WORLD PETROLEUM

MARCH 1958

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THIS MONTH'S COVER

Pan American Petroleum Corporation's shooter O. L. Ray exploring a remote prospect in Arizona. Color plates of the Arizona operation are reproduced through the courtesy of Allan B. Carleton, editor of *Horizons*, house magazine of Pan American Petroleum. Decoration is a modern method of presenting seismic data by means of a Variable Intensity Plotter. Photo of this segment of a depth section courtesy Texas Instruments, Inc.

Washington PIPE LINE

by Joseph Huttlinger

Import Controls Face Problems

The "voluntary" program to limit crude oil imports to the U. S. is facing some tough problems. Some 18 new companies have asked to bring in a total of nearly 200,000 b/d over the present quota. Hearings began Feb. 10.

Some companies are bringing in crude oil without a government allocation. Delta Refining Co., Memphis, Tenn., began bringing in crude from Venezuela in January. Superior Oil Co. is the supplier. Delta said the flow might reach 20,000 b/d.

A few companies are exceeding their quotas. Tidewater Oil Co. is an example. Its supplier is Getty Oil Co., operating in the Middle East.

Defense Department has been undercutting the program by buying more oil products in the Caribbean area. Defense says it has a "lowest bidder" policy. But, the pressure is on to persuade Defense to buy more in the U. S.

Canadians and Venezuelans have been stepping up their protests, and warning of retaliation. Canada is making the logical appeal that the U. S. national security should allow in any oil that comes by pipeline.

Sen. Joseph C. O'Mahoney, D., Wyo., for one, sees "cracks" in the program, and says that Congress may have to act. Once, he called for higher tariffs and another time he asked a quota law.

Captain M. V. Carson, imports administrator, has warned that "tariffs and mandatory quotas are real alternatives" if the present program breaks down. Those who wreck the program, he said, will be blamed by the rest of the industry for any controls that come. And, he added, quotas tend to lead to higher prices, thus to price controls, thus to rationing, thus to policing, and finally to complete control by bureaucracy. Tariffs, he said, raise the price of oil, but don't keep it out unless they are at the prohibitive level. If they are that high, he said, they don't let in enough oil to supplement domestic supply, which is what is wanted. In any event, they lead to tariff wars.

Independent Petroleum Association of America, meanwhile, unfolded a specific weapon to meet the situation. It asked Congress for a law saying imports of (1) crude oil and (2) oil products should be held to the 1954 relationship to domestic demand. This would be 770,000 b/d for crude oil, instead of 990,000 allowed under the "voluntary" program. IPAA also proposed that any oil or products over the allowable pay a duty of 30% or about $1 a barrel. This, IPAA said, would be prohibitive. Gordon Simpson, IPAA president, called a meeting of 20 other oil associations at Tulsa, Jan. 31, to line up industry wide support for the proposal.

As many observers see it, the "voluntary" program is living on borrowed time. A few months ago, the program was working but after eight months, there are signs that the line is about to be breached. Sacrifice by many companies and great sacrifices by a few will be required to save it.

Unless the "voluntary" program works for a few months longer, the Congress is likely to stiffen the law in some fashion when it considers extension of the Reciprocal Trade Agreements Act. Either that, or the President will take some action on his own to stiffen the program. Surprise in the program is that it worked so well, for so long. And that, largely, is due to the personality of Captain Carson, respected by all, and the backing he had from top levels in government.

Gordon Gray, defense mobilizer, has decided no action is necessary at this time to lower imports of residual fuel oil to Districts I through IV. Mr. Gray, at a meeting with officials of the Office of Oil and Gas of the Department of the Interior, studied figures on past and projected imports of residual fuel oil from the bulk of the importers, as furnished by companies in response to a questionnaire. The figures showed the companies plan to bring in 506,700 b/d in the five months ending April 1958, compared with actual residual imports a year earlier of 565,000 b/d. USA officials said the figures are not strictly comparable, as the year-ago figures are total residual imports, and the companies reporting plan include most, but not all, importers.

Companies are asked to supply figures each month to the Office of Oil and Gas on their planned residual imports. The first report, due December 16, showed these figures:

November, 1957	Actual	439,300 b/d
December, 1957	Est.	560,300 b/d
January, 1958	Est.	541,600 b/d
February, 1958	Est.	536,000 b/d
March, 1958	Est.	473,300 b/d
April, 1958	Est.	422,500 b/d

The Department of Defense, which buys petroleum products from the lowest bidder, has been giving more of the business to Caribbean refiners in recent months. Result has been a storm of protest by U. S. refiners.

The Defense Department defended its actions in a statement by Earl V. Smith, director of transportation, Office of the Assistant Secretary of Defense. He said: "National security considerations dictate the necessity for appropriate peacetime utilization of friendly foreign petroleum resources, thereby assuring adequate availability of such resources in an emergency.

"To accomplish this objective, it was determined that it would be consistent with the public interest to discriminate against a friendly foreign industry instead of allowing such industry to compete on an equal basis with our domestic industry."

Secretary of Commerce Sinclair F. Weeks, chairman of the Cabinet Committee on crude oil imports, meanwhile, has been asked to "investigate" the matter.

Petrochemical Construction

The petrochemical industry in the U. S. will spend about $193 million for new production facilities during 1958 and 1959, it is estimated by the Manufacturing Chemists' Association. The total includes $88,550,000 under construction and $104,750,000 planned.

Air Force Oil Purchases

The U. S. Air Force, the largest single customer for petroleum products in the world, may handle about $744 million worth of petroleum products during the year that ends next June 30, the budget of the President discloses. The year after, the figure may be about $800 million. For the Navy, the figures are $321 million and $352 million. For the Marine Corps the figures are $5.1 million and $5.1 million.

Depletion Hearings

The depletion allowance for oil and gas production was attacked and defended at hearings before the House Ways and Means committee during January. Chairman Wilbur Mills, D., Ark., however, said the committee had no intention of changing the allowance at this time.

A labor union spokesman urged Congress to collect an extra $1 billion or more a year by shaving down income tax depletion allowances on minerals. Former Senator and Former Governor Ed. C. Johnson of Colorado, a Democrat, warned that without the allowance "the price of gasoline would be 50% higher" and U.S. oil production would be "alarmingly low."

Mr. Johnson was the main witness in the current drive for a 27.5% depletion allowance for oil shale. At present, he said, shale gets 15%. Others asking this were Richard S. Kitchen, chairman of the Committee for Oil Shale Development; A. C. Rubel, president of Union Oil Co., and Fred L. Hartley, vice president; H. T. Lentz, a technician; officials of Colorado Chambers of Commerce, and the entire Colorado delegation in the U. S. Congress.

National Coal Association, meanwhile, urged that coal be given a depletion allowance of 15% instead of 10% now allowed. Otto Gressens, head of NCA's tax committee, insisted, however, that he makes no allegation that oil's rate of 27.5% is too high.

Oil producing associations, which had planned to have witnesses define oil's depletion, changed their plans upon word of Chairman Mills that he did not plan to go into rate changes for oil's depletion. Secretary of the Treasury Robert B. Anderson endorsed "the principle of depletion" for certain minerals, in his first appearance before the committee since he took over the Treasury post.

"Cartel" Case May Be Tried

The antitrust action against five members of the so-called "oil cartel" may go to trial after all. Attorney General William P. Rogers said recently "we plan to go ahead and fight this matter in the courts." He said U. S. District Judge Cashin of the Southern District of New York has been assigned the case. He said a schedule for filing of motions is being set up. He added, "There are no negotiations pending now" for a consent settlement. "But I wouldn't want to foreclose the possibility of a consent settlement."

The case began in the closing days of the Truman administration with the filing of an antitrust action against Standard Oil Co. (N.J.), Standard Oil Co. (Calif.), Socony-Vacuum Oil Co., The Texas Co., and Gulf Oil Corp. Last August, terms of a consent settlement were discussed and virtually agreed to, it was reported.

"Planned Oil Economy"

The Fund for the Republic has published a study which says the crude oil proration system has brought "a planned oil economy." Supply is equated to demand and the oil industry from well to refinery to gas station is more or less geared to meet it, the report says. A. A. Berle, Jr., professor of corporation law at Columbia University, and former Assistant Secretary of State, is the author of the study, entitled "Economic Power and the Free Society."

Kills State Gas Price Control

The U. S. Supreme Court said a state may not set a minimum price for natural gas at the wellhead. The decision came in a case where Kansas set 11¢ per MCF as the floor. The court did not explain its reasoning. Kansas officials said this is proper conservation. Federal Power Commission and Department of Justice claimed this interferes with FPC's duty to regulate the price of gas at the wellhead.

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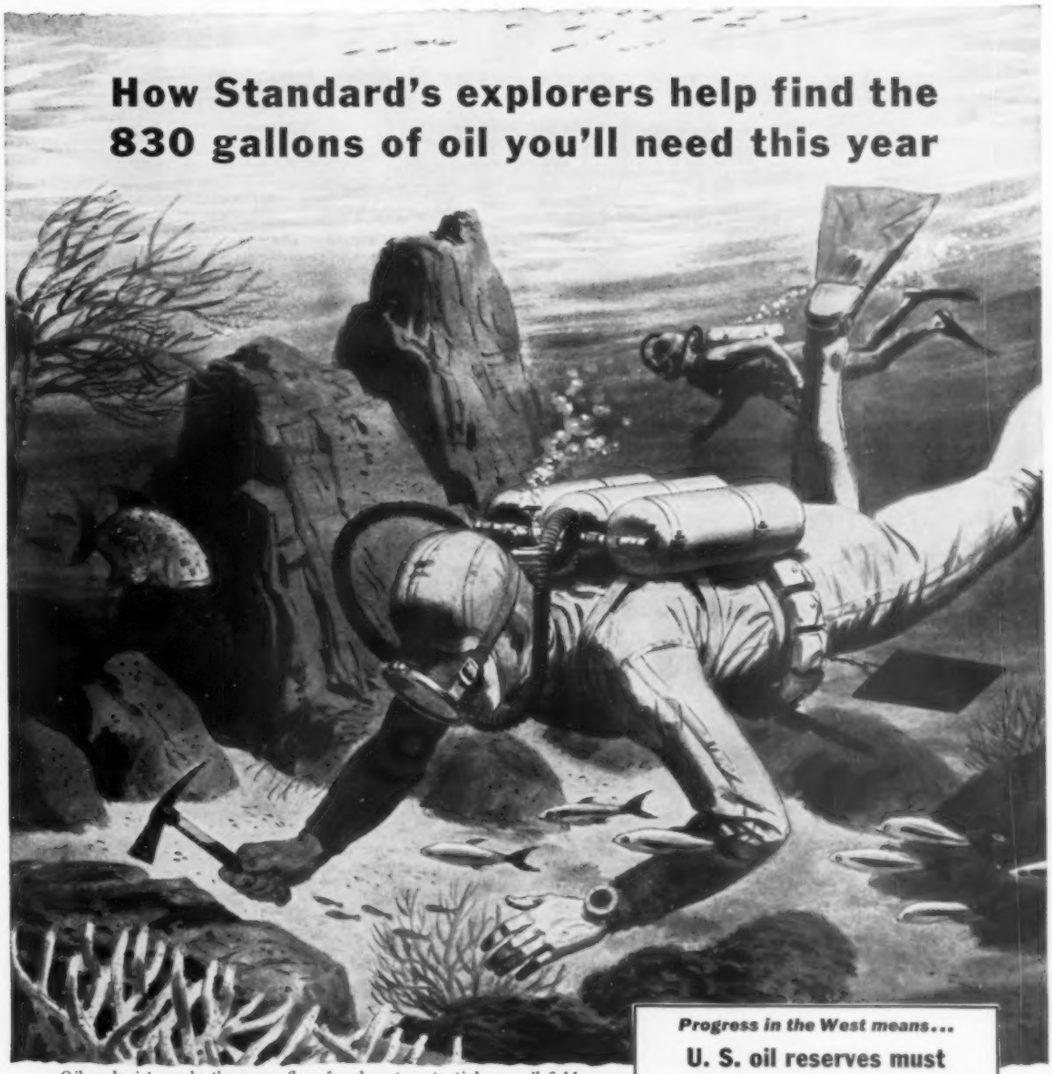

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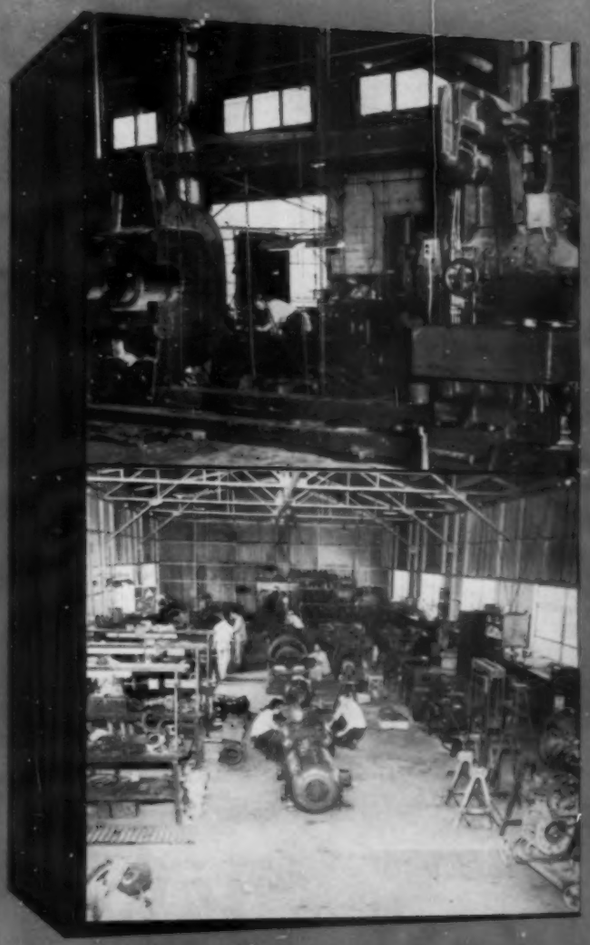

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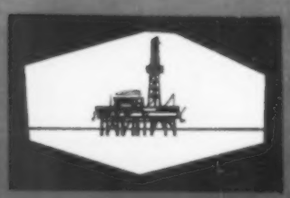

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Latin American Oil News

To Share Development of "IPC" Paraguayan Concession

International Products Corp. has announced signing of agreement with Rimrock Tidelands Inc. for the two companies to share in development of the 7,500,000-acre oil exploration and exploitation concession granted to International Products in 1957 by the Paraguayan government. Concession consists of three tracts in the Chaco region of Paraguay, and is located in the same general area where Pure Oil Co. holds a large concession on which it has announced plans to commence drilling operations immediately.

Two of the tracts of the International Products concession, totaling about four million acres, lie along and parallel the Bolivian and Argentine borders. They are located close to five Bolivian and three Argentine oil and gas fields, which are productive in the Devonian formation. The third tract of about 3,500,000 acres adjoins the Pure Oil concession in northeastern Paraguay.

San Jacinto Organizational Changes

Organizational changes by San Jacinto Petroleum Corp. have been announced by Benno C. Schmidt, chairman. Company's domestic operations will be handled by San Jacinto Oil & Gas Co., a newly formed division of the corporation—with its principal offices in Houston. B. G. Martin will serve as president of San Jacinto Oil & Gas Co.

Venezuelan operations of the company will be conducted through San Jacinto Venezuelana CA, wholly owned subsidiary, with offices in Caracas and Maracaibo, Venezuela. L. W. Goodrich, for the past three years in charge of production operations of the parent corp., has moved to Maracaibo to assume responsibilities of vice president-in-charge-of-operations of the Venezuelan company.

New Colombian Study

The history and present operations of Empresa Colombiana de Petroleos are set forth in a recent publication, *Breve Resena General de la Empresa Colombiana de Petroleos*. The publication includes technical details on the company's pipeline and on its refinery at Barrancabermeja, and points out that in 1948 studies forecast that the de Mares concession would decline to 15,000 b/d production by 1957, while in fact production now is about 30,000 b/d. The new gas-turbine power system for de Mares is described, as well as the secondary-recovery operations being undertaken by the Forest Oil Co.

High-Powered Brown Rig for Venezuela

A new super-powered oil-well drilling rig has been put in operation in Maracaibo, Venezuela. Assembled in Long Beach (Calif.) by International Brown Drilling Co., the large outfit has a "power package" consisting of three 800-hp engines. Despite the enormous power available, the hydraulic drive into which the power will be fed enables operators to reduce the force to just a mere whisper of power, for delicate drilling operations, according to A. J. Heiser, vice president of the drilling contracting firm.

The unit, to which many equipment manufacturers contributed components, can efficiently handle drilling operations to 15,000 ft.

The new unit is the fourth sent to Venezuela by the firm's foreign division, International Brown Drilling Co.

JOSEPH A. KEELING has been appointed head of the exploration department of Phillips Petroleum Co. of Caracas.

Colombian Grant Transferred

Dr. Victor Oppenheim, partner in the Dallas petroleum consulting firm of Oppenheim & Briscoe, has announced transfer of a 40,000-acre petroleum concession in Colombia to Ambassador Oil Corp., Fort Worth. Transaction calls for Ambassador to start immediately on exploration work and to drill a minimum of two wells each year for an unstated number of years. Dr. Oppenheim said he would retain an overriding interest on the acreage.

Location of the concession was said to be along the Sinu River, about 100 miles south of the Caribbean coast in the state of Cordova. Geologically, it is in the Sinu basin, where other acreage is held by major American companies.

Creole's Desulfurizer Onstream

Operation of Creole Petroleum Corp.'s new desulfurization plant was started recently at its Amuay refinery in Venezuela. The Hydrofiner is the only one of its kind in Venezuela. It is used for treating diesel oils used locally, and for export. It was constructed by the Foster Wheeler Corp. at a cost of $3 million.

Quantities of sulfur normally existing in diesel oils will be substantially reduced by using the hydrogen available from the treating reaction of gasolines in the hydroformer. The Hydrofiner will treat up to 17,500 b/d of diesel oils.

Builds Mexican Plant

Cameron Iron Works of Mexico is to start promptly construction of a factory in Mexico City for production of oil-field equipment. The company plans to turn out a complete line of oil and gas well control equipment and certain items of oil refining. These will be finished from raw forgings received from the Houston plant.

Gulf Acquires Latin American Marketing

Gulf Petroleum SA has announced acquisition of Union Oil Co. of California's marketing outlets in Panama and Panama Canal Zone. Gulf Costa Rica Co. SA, a Gulf Petroleum subsidiary, has announced acquisition of similar properties of Union oil in Costa Rica. Gulf Petroleum is a subsidiary of Gulf Oil Corp. No price was announced for either acquisition.

San Jacinto New York Office

Rockefeller Center Inc. has announced signing of a long-term lease with San Jacinto Petroleum Corp. for executive and sales offices in the International Building, 630 Fifth Ave. This will be company's home office. Offices are maintained also in Houston, Texas, and in Caracas and Maracaibo, Venezuela.

Havana Petroleum Club 1958

Following have been elected officers of Havana Petroleum Club for 1958: President: H. L. Brandon (Union Oil Co. of California); vice president, A. H. Ferguson (Cuba-California Oil Co.); treasurer, J. Hall (Cuban Stanolind Oil Co.); vice-treasurer, A. H. Smith (Cuba-California Oil Co.); secretary, E. Arango (Cuban Stanolind Oil Co.); vice-secretary, J. Faz Vega (Atlantic Refining Co. of Cuba).

Argentine Refinery Expansion

The Argentine government has approved a contract with M. W. Kellogg Co. for expansion of an oil refinery at Lujan de Cuyo. Expansion will consist of a 28,000 b/d crude distillation unit, a 18,500 b/d delayed coker, and an 11,000 b/d Orthoflow catalytic cracker and gas-recovery unit. Offsite facilities will include a utility plant with steam generation, boiler fed-water treating, compressed air, and dual fuel-oil and fuel-gas systems. Crude and intermediate product systems will include crude tankage and crude transfer lines and pumps.

Petrosur-Hydroil Merger

Petrosur Oil Corp. Inc. has acquired Hydroil Inc., Houston producing company, through an exchange of shares. John W. Flude has been elected president of Petrosur.

Administrative offices of Petrosur will continue in New York. Field headquarters will be in the San Jacinto Building, Houston.

Petrosur has leases and concessions in Panama, Venezuela, Bolivia, Cuba, and the United States.

Brazil Reports Operations

According to official figures, crude production in Brazil, January 1 through October 31, 1957, totaled 7,695,244 bbl (November estimate, 37,000 b/d; December 40,000 b/d). 54 rigs were operated—of which 31 were in Bahia Reconcavo. Petrobras expects Bahia production to rise to 44,000 b/d with opening of new 39-mile 12-in. pipeline from Catu to ocean terminal of Madre de Deus. Carrying capacity will be 60,000 b/d—twice that of the Catu-Mata-Candeias line begun in 1956. Tanks to store 268,000 bbl and a new pumping station are being erected at Catu, and storage capacity at Madre de Deus is being raised to 520,000 bbl.

Shipments of crude from Madre de Deus to the southern refineries totaled 6,013,054 bbl between January 1 and November 17, 1957. Presidente Bernardes received 5,721,199 bbl; Refinaria Uniao, at Capuava, 213,759; Manguinhos refinery in the Federal District, 78,096 bbl.

Between January 1 and October 31, Petrobras completed 71 wells—including wildcats; structural, stratigraphic, and development wells; 41 produce oil and 2 gas.

In November drilling was started at Sao Paulo; at Pitanga, between the cities of Rio Claro and Piracicaba, using a Cardwell J-450 drill for 6,000-ft depths; in Amazon basin at XUST-1-AZ, 48 miles northeast of Altamira on the Xingu River; and SO-1-AZ, at Sampai, near Nova Olinda.

Petrobras has been drilling 22 wildcats in five sedimentary areas, viz.: in the Amazon basin, 9; in Maranham, Alagoas, and Sao Paulo, 2 each; in Bahia, 6; in Parana, 1. 27 new locations have been marked for drilling early in 1958.

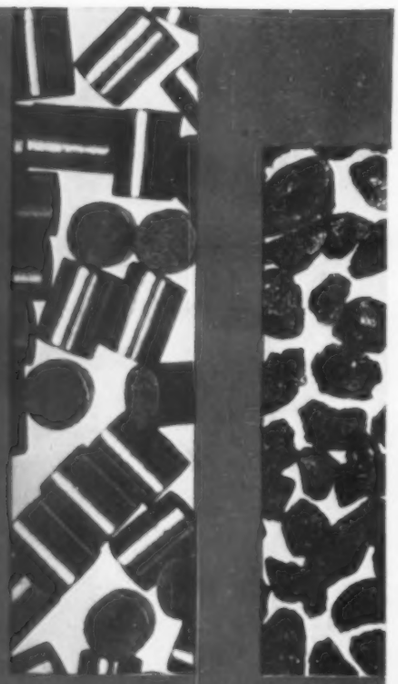
Three teams—two geological and one geophysical—are operating in the Bahia Reconcavo; geologists are surveying along the coast from Caravelas to the state of Espirito Santo, where drilling is to start within the next two years.

Congress has authorized a credit of 400,000,000 cruzeiros to build an oil refinery at Corumba, in Mato Grosso.

POSITION OF WILDCAT DRILLING
(November 27, 1957)

WELL	DEPTH
Amazon Basin	*(Feet)*
NO-3-AZ (Nova Olinda)	9,321
NO-4-AZ (Nova Olinda)	7,426
UA-1-AZ (Uraria)	10,653
AR-1-AZ (Arari)	2,382
SO-1-AZ (Sampaio)	2,853
UR-1-AZ (Urubus)	1,183
MN-St-1-AZ (Manaus)	4,144
AIST-1-AZ (Acari)	3,130
XUST-1-AZ (Xingu)	1,085
Maranham Basin	
Md-1-Ma (Mirador)	6,929
RP-1-Ma (Rio de Peixe)	3,793
Bahia Reconcavo South	*(Feet)*
SP-1-BA	6,243
MF-1-BA	8,330
DJC-1-BA	3,721
DJX-4-BA	175
Alagoas	
JA-1-AL (Jequia)	5,028
Parana	
MA-1-PR (Mallet)	479
Sao Paulo	
*PE-St-1-SP Presidente Epitacio	9,587

* Awaiting change of rig.



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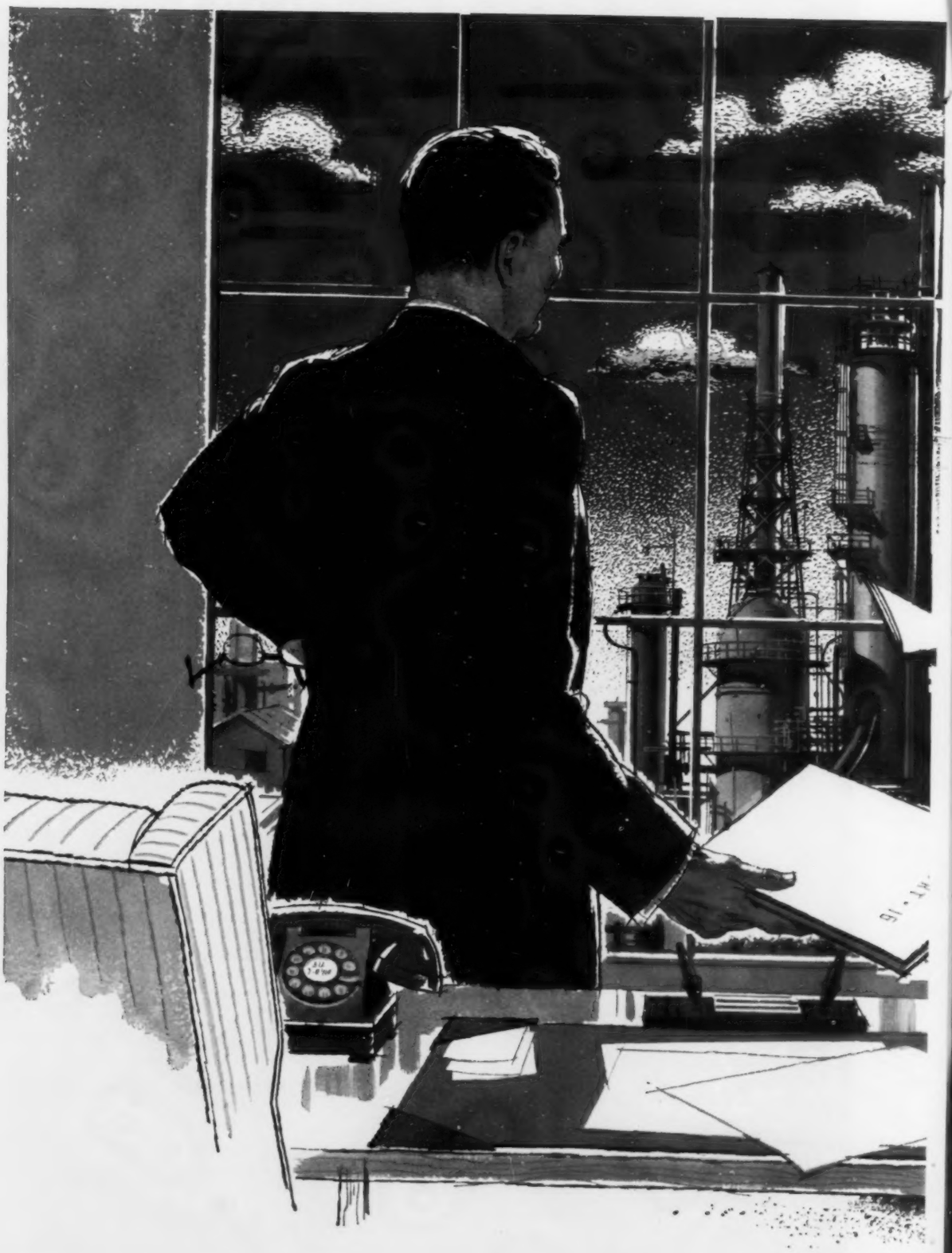

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London Letter

By A. L. Paget

Recession and Oil Demand

The latter months of 1957 gave some indication of a recession in industrial activity in the free world. This naturally poses the question as to what will be the effect on oil demand. The brief answer is that hitherto the effect has been significantly less than in most other sectors of world economy.

In a paper read to the Institute of Petroleum, Messrs. G. Chandler and D. A. Lindsell, of Shell Petroleum, presented a timely survey of the relationship between black oils and fluctuations in economic activity. The main points included an analysis of the total demand for energy which, on the average, varies by 0.7% to 0.8% for every 1% rise or fall in industrial production. If black oils alone are considered, the fluctuation is much less.

In Western Europe, even during a recession, the demand continued to grow for black oils as a substitute for coal.

Other matters discussed by the authors included price variations, restrictions on imported oil, the effect of nuclear power, and the needs of shipping which naturally vary in sympathy with the volume of seaborne trade. It should be noted that the demand for black oils for heating and for gasoline for private motoring is not greatly influenced by short-term fluctuations in economic activity.

India's Oil Demand

India's five-year plan is likely to have a considerable effect on her demand for oil. Inland oil demand should rise substantially above the present level of 5¼ million tons a year. Production, now 400,000 tons a year, could, in due course, rise to nearly 3 million tons if agreement can be reached between the government and Assam Oil on the development of recently discovered areas at Nahorkatiya and Hugrijan. Some exploration is in progress in various parts of the sub-continent, but very much more is needed; and conditions must be made more attractive to the oil explorer if India's long-term needs are to be met. The main obstacle to economic development in general is the shortage of foreign exchange.

INDIA'S ESTIMATED INLAND CONSUMPTION OF PETROLEUM PRODUCTS
(Thousand Long Tons)

	1951	1955	1956	1957*
Gasoline	900	900	960	1,000
Kerosine	1,050	1,470	1,500	1,600
Diesel fuels	650	850	970	1,150
Fuel oils	620	680	730	850
Other products	350	560	670	650
	3,570	4,460	4,830	5,250

*Partly estimated.

Oil and Education

Recent events have indicated a serious shortage of scientists and technicians in the free world. It was appropriate, therefore, that Lord Godber of Mayfield, chairman of Shell Transport and Trading Co. Ltd., should take "Oil and Education" as his subject for the Institute of Petroleum's Cadman Lecture. He emphasized that, while the oil industry needs geologists, physicists, chemists, and other specialists, there is an equally urgent demand for men of varied experience, breadth of vision, imagination, and other higher faculties of mind which are fostered by a liberal education. After describing how the oil companies have extended the scope of their educational activities beyond the limited field of vocational training, Lord Godber claimed that the benefits of their expenditure in this direction would be reaped by society at large, and not least by Western Europe and the United States.

Mobil Oil's New Medical Service

For the benefit of the continued good health of its employees, Mobil Oil has recently created a central and coordinating medical department in London. Service by this department, under the control of Dr. W. L. B. Leese, the company's chief medical officer, is complementary to the National Health Service. It has been instituted to help maintain the high level of employee health as well as healthy working conditions, and to assist management in selecting employees who are medically fit for the duties to which they are assigned.

The new department is furnished with all the requisite modern medical equipment, and includes a treatment room where first-aid, physiotherapy, etc., are given. At the company's Coryton refinery, and at Birkenhead and Wandsworth works, local doctors are in regular attendance.

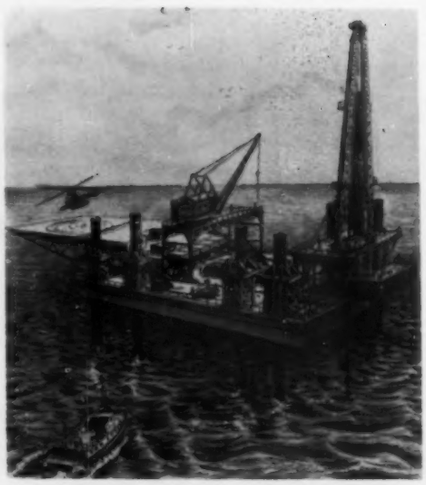
All-Wheel-Drive Tankers

Douglas Equipment Ltd. announce a new addition to their range of all-wheel-drive tankers, the Pathfinder, which is designed for cross-country duties, oil-field exploration, and general desert conditions. It is capable of carrying a payload of up to 30 cwt. A feature of the front driving axle is the independent front suspension incorporating wish-bones and double-coil springs. The vehicle can be fitted with 11.00 x 16 twin-front and twin-rear sand tires for flotation—giving a ground pressure of approximately 15 psi laden. Speed variation is from 1.45 to 60 mph; the maximum gradient possible is 1 in 2.

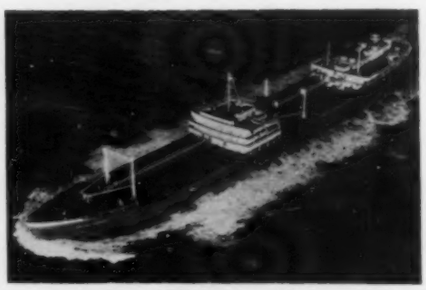
W. H. Apthorpe Retires

W. H. Apthorpe, managing director of the Cambridge Instrument Co. Ltd., retired from executive duties at the end of 1957. He retains his seat on the board, and will con-

(Continued on page 101)

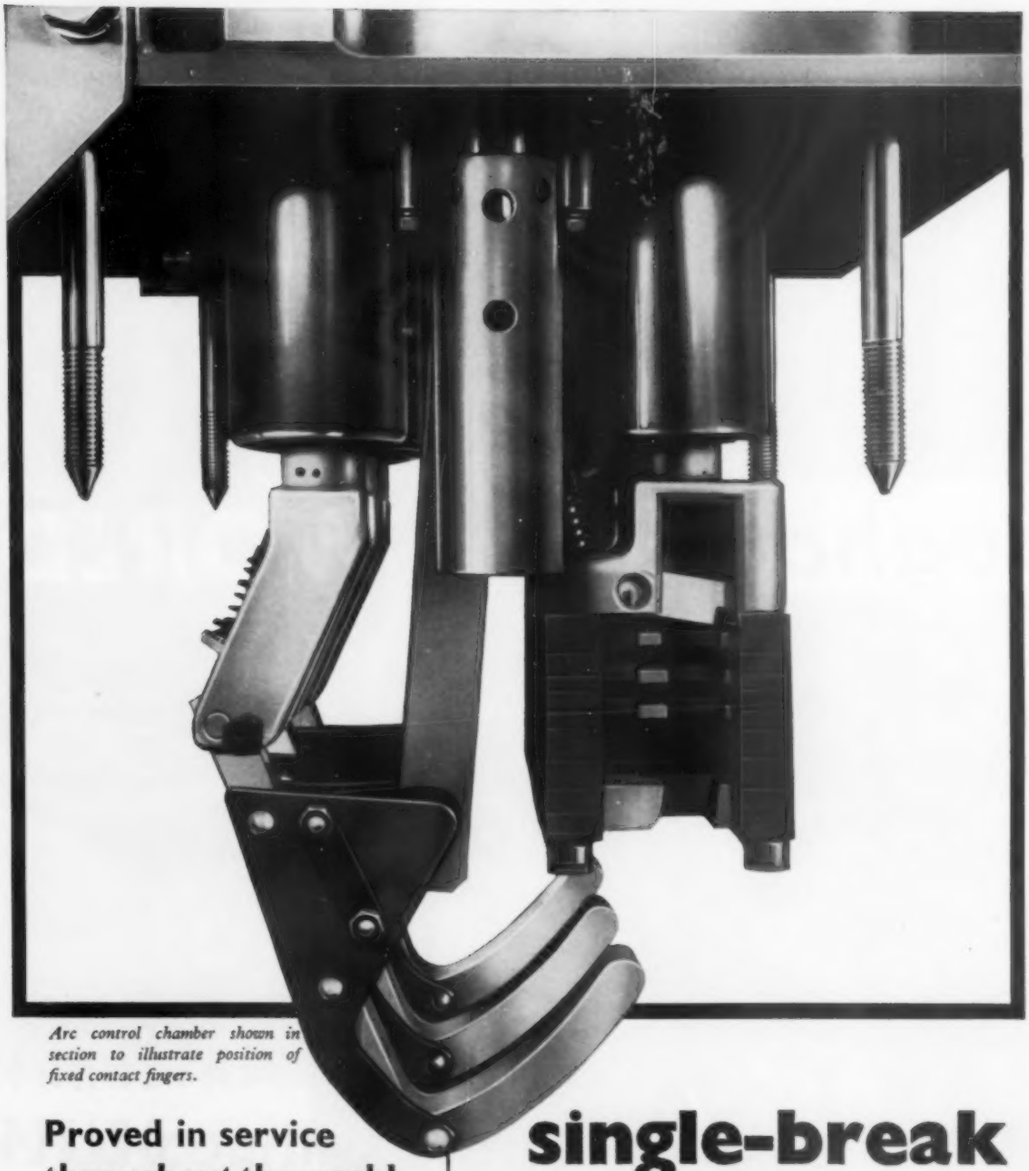


Artist's drawing of Royal Dutch-Shell drilling platform being built for Persian Gulf service: Design is to withstand 100-mile winds and 30-ft waves. Platform will drill in water up to 100 ft in depth. Drilling mast is to be mounted on sliding way for multiple wells from a single platform location.



BP Tanker Co.'s 32,000 dwt "British Courage" on recent speed trials.

British Petroleum Co. is testing hydrant fueling systems for jet-powered aircraft. Fuel is pumped through 1,000-ft lines through aircraft valves and fuel-dispensing units to actual aircraft tank structures to test surge effects under varying operating conditions.



Arc control chamber shown in section to illustrate position of fixed contact fingers.

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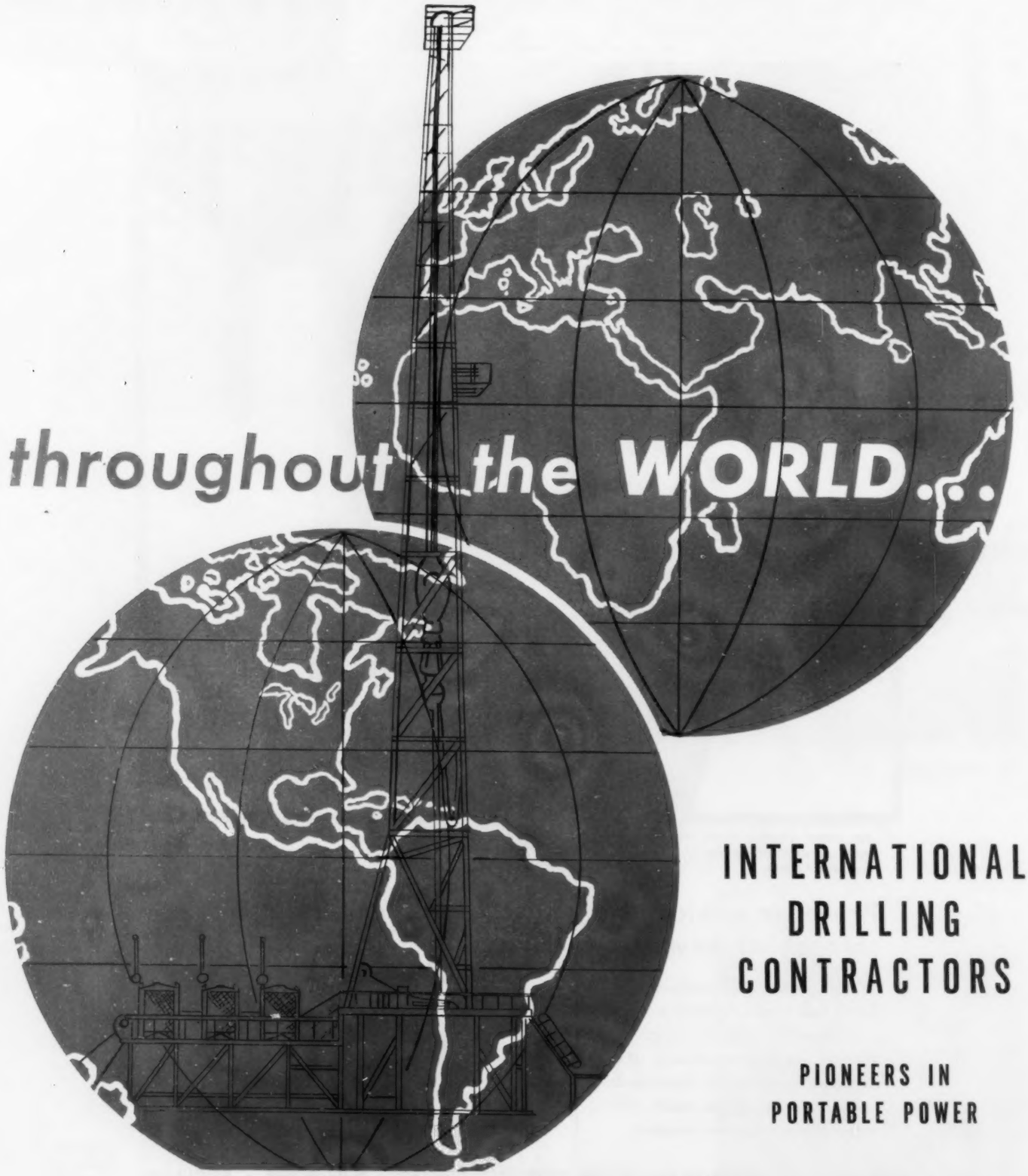

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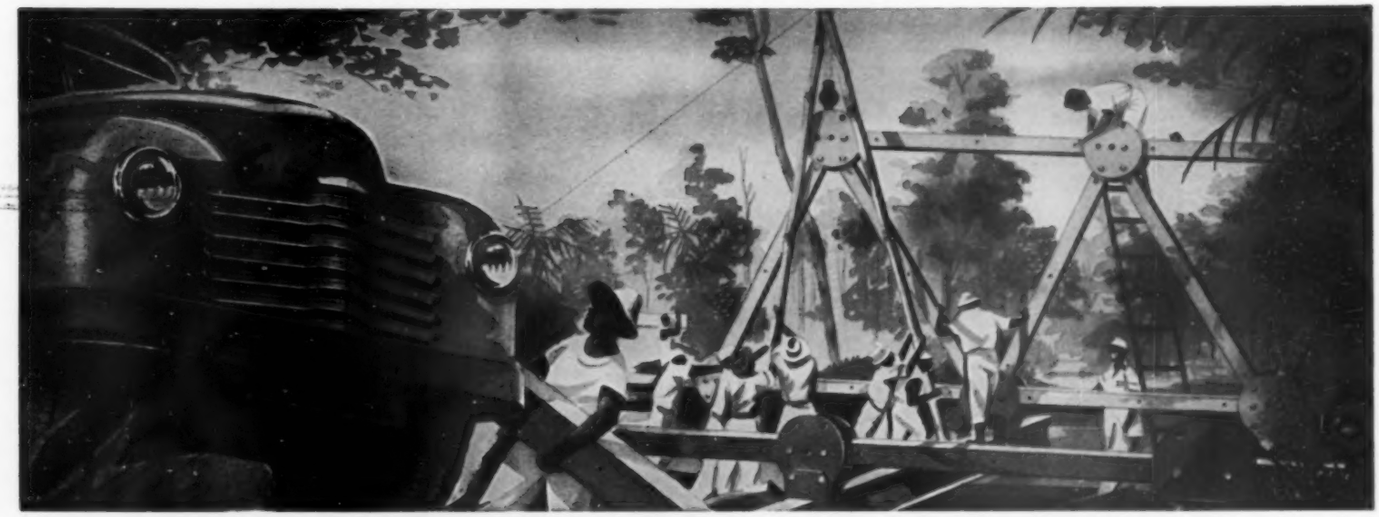
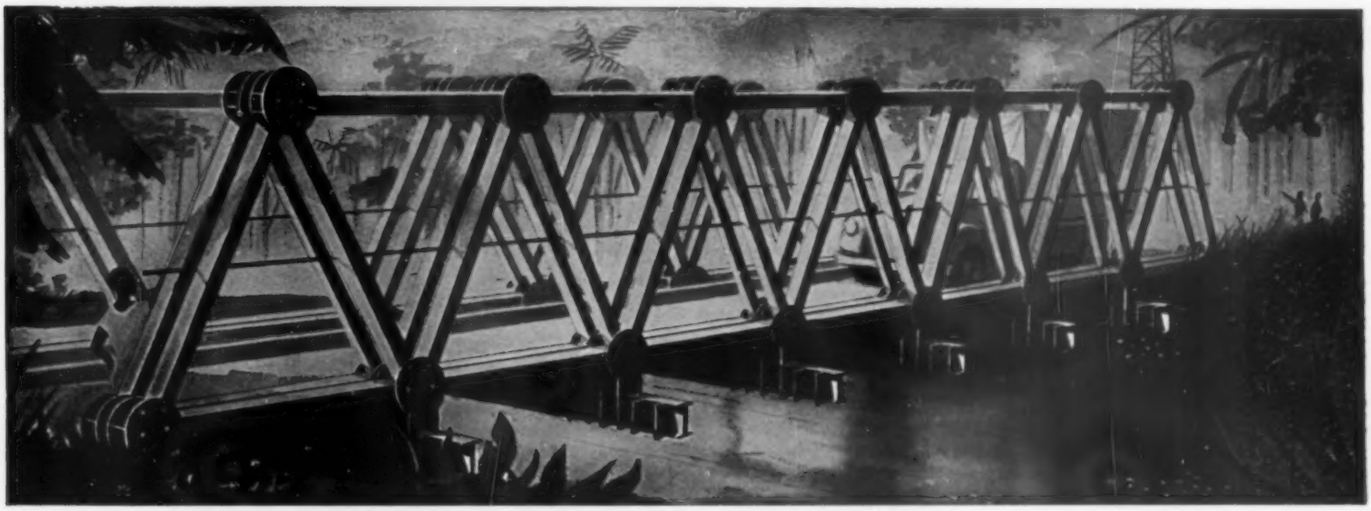


and quickly erected on . . .



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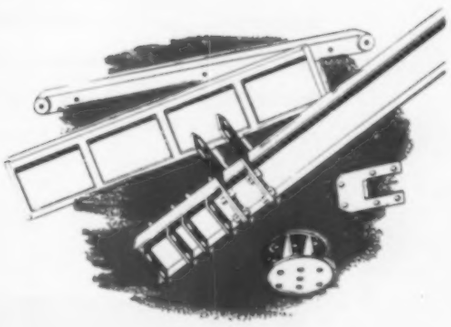

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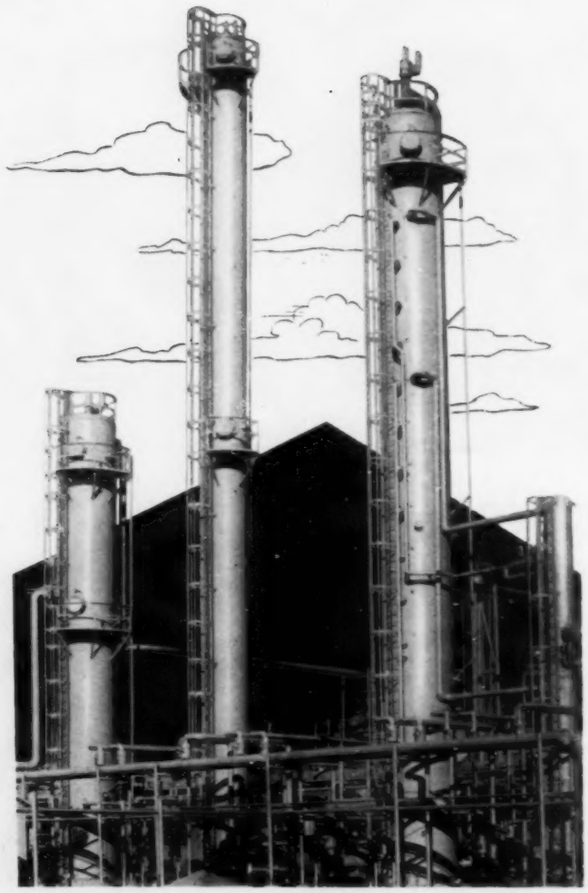

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Out of the millions of dollars being spent annually by Hughes in research are coming constantly improved bits to help you make hole faster and more economically.

Why spend 150% more for your tool joints?

Records show that Hughes hardfaced tool joints give you service equal to two and often three sets of non-hardfaced joints . . . at a fraction of the cost!

For that reason most contractors and operators who expect to use their drilling strings in abrasive formations buy hardfaced joints.

Hughes tool joints are hardfaced with a Hughes-developed carbide hardfacing—*"Hughesite"*—more than 25 times as wear-resistant as hardened steel. Application is by a special Hughes-developed process that assures uniform distribution of carbide particles for maximum resistance to wear.

You get the best possible protection for tool joints when you get Hughes hardfacing . . . proved in 15 years of field service and on millions of feet of drill stem.

HARDFACING is available on "Seal-Grip" and on tapered and square shoulder "Flash-Weld" tool joints.

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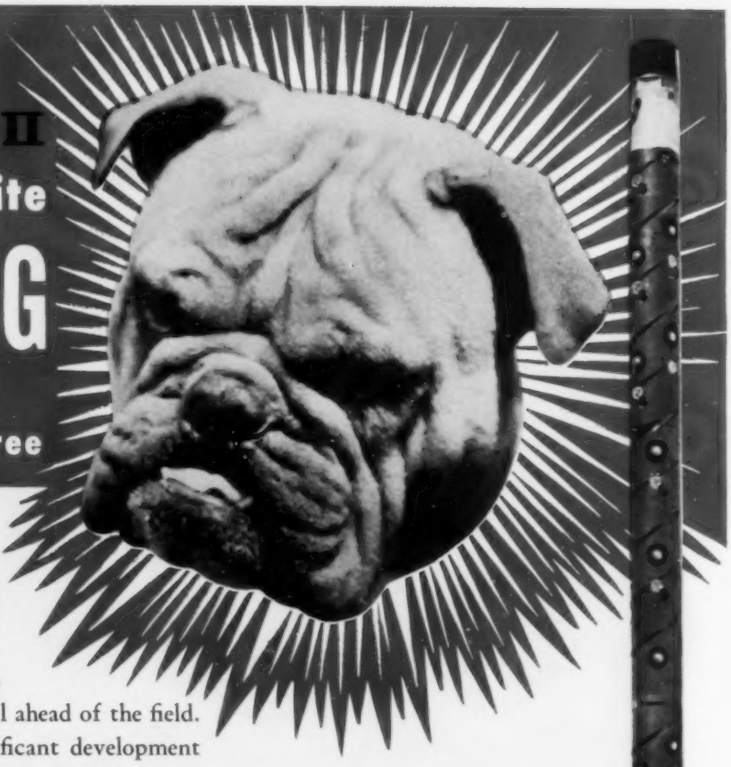
Now—PGAC'S ATLAS II with Deeper Bite is the ATLAS BULLDOG

. . . the Bullet Gun with an Enviable Pedigree



For the past 12 years leading operators have called PGAC's Atlas and Atlas II bullet guns the Oil Industry's *safest and most powerful bullet perforators.* PGAC's research improved these guns year after year and kept them always well ahead of the field.

Now, as the result of another significant development *—a new powder which increases penetration 70% over that of even the Atlas II*—PGAC hereafter designates this more powerful bullet gun as the "Atlas BULLDOG."

The Atlas BULLDOG retains all of the basic features and outstanding advantages of the Atlas and Atlas II guns.

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Unretouched photo (lower left) shows the remarkable bullet penetration of over 9" from a 4" O.D. Atlas BULLDOG gun, typical of several test shots *fired under 2500 p.s.i. hydrostatic pressure at 180°F.* Tests with 5-7/16" O.D. Atlas BULLDOG guns produced much deeper bullet penetrations.

The targets were constructed *by a Major Oil Company,* and all tests were conducted recently *under their complete control.*

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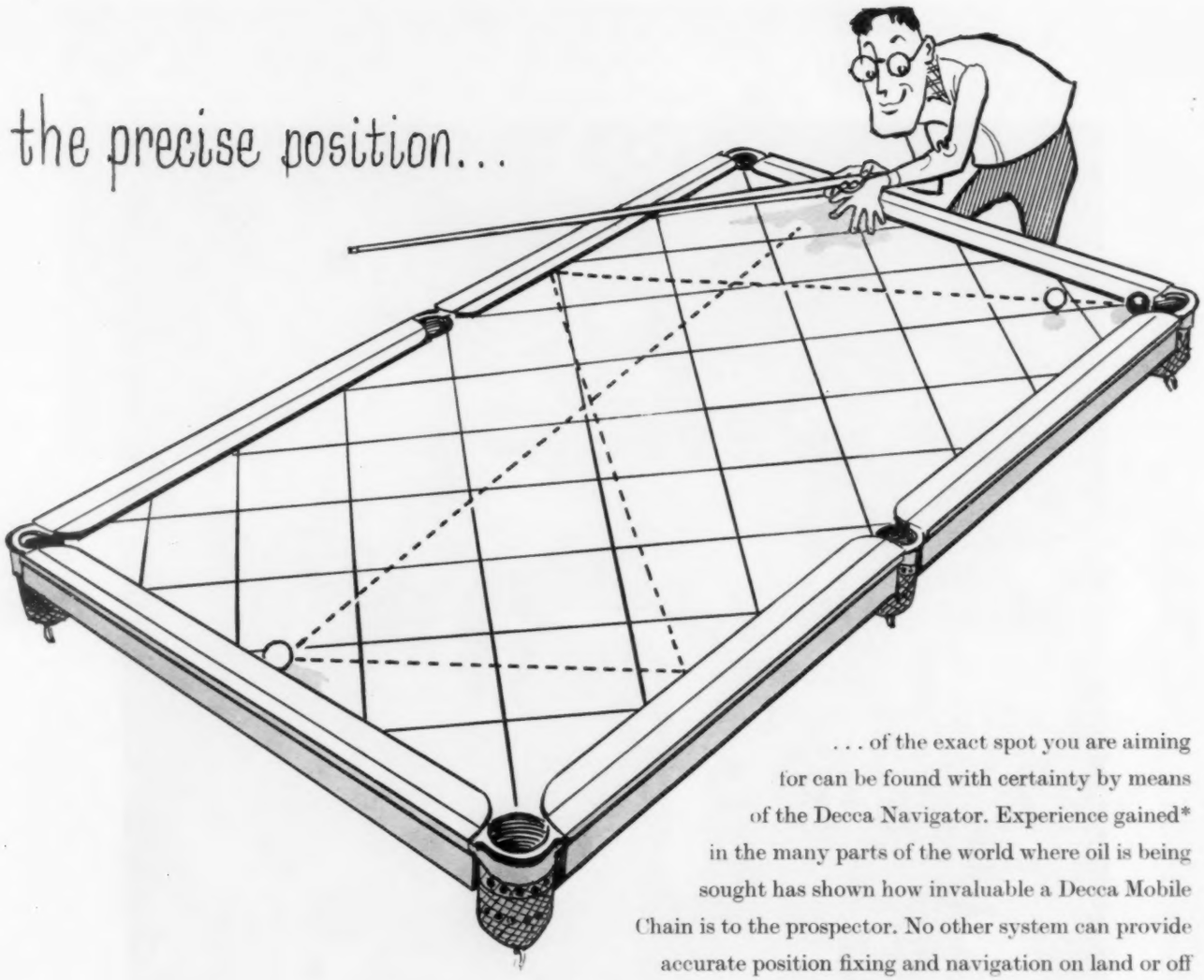

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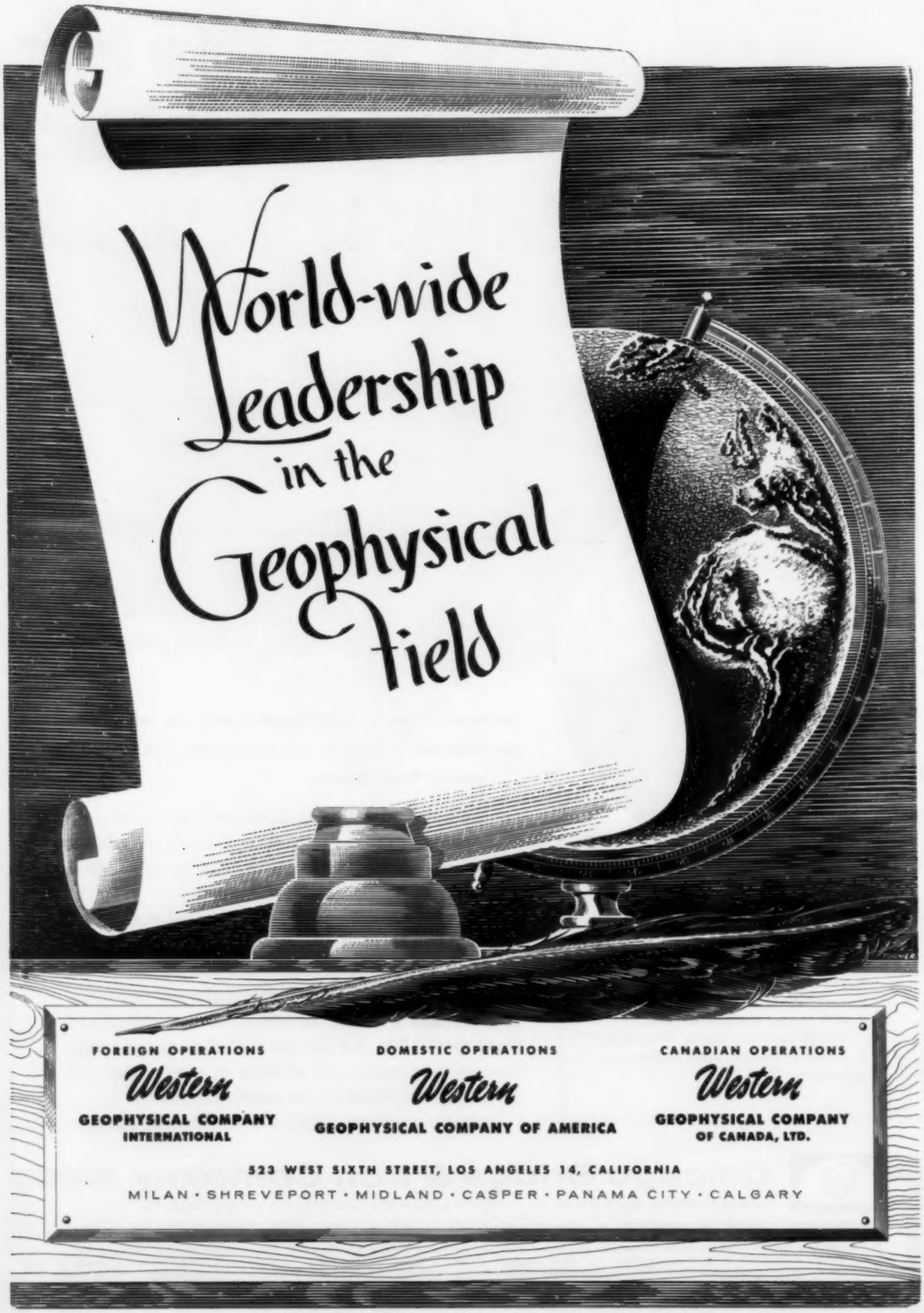
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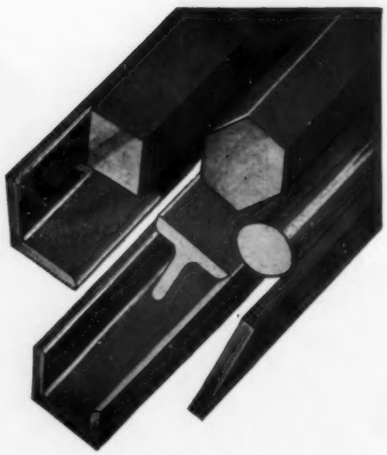

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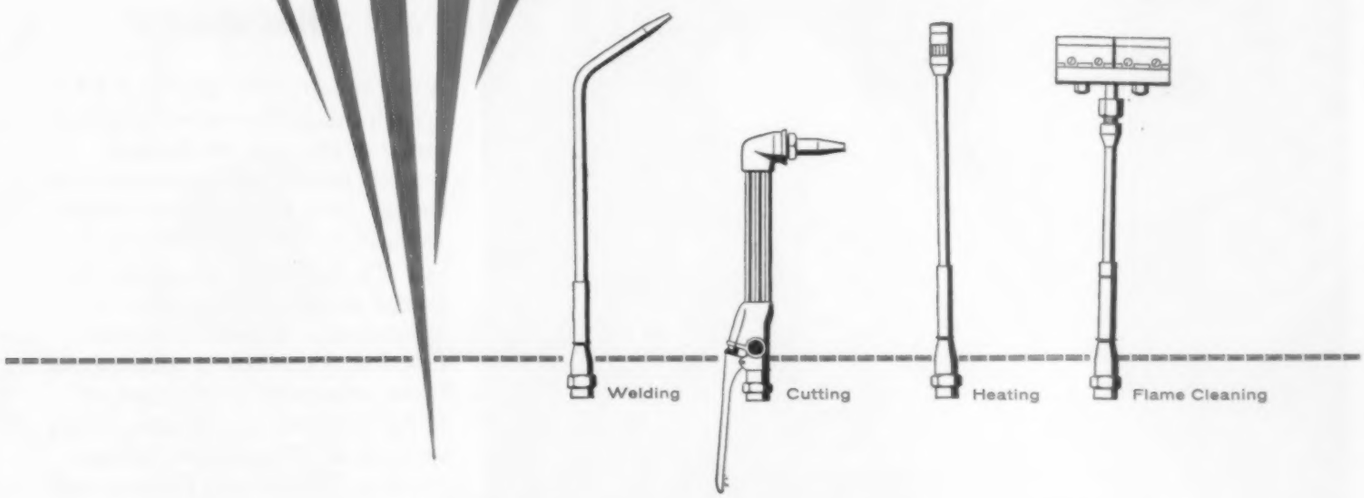

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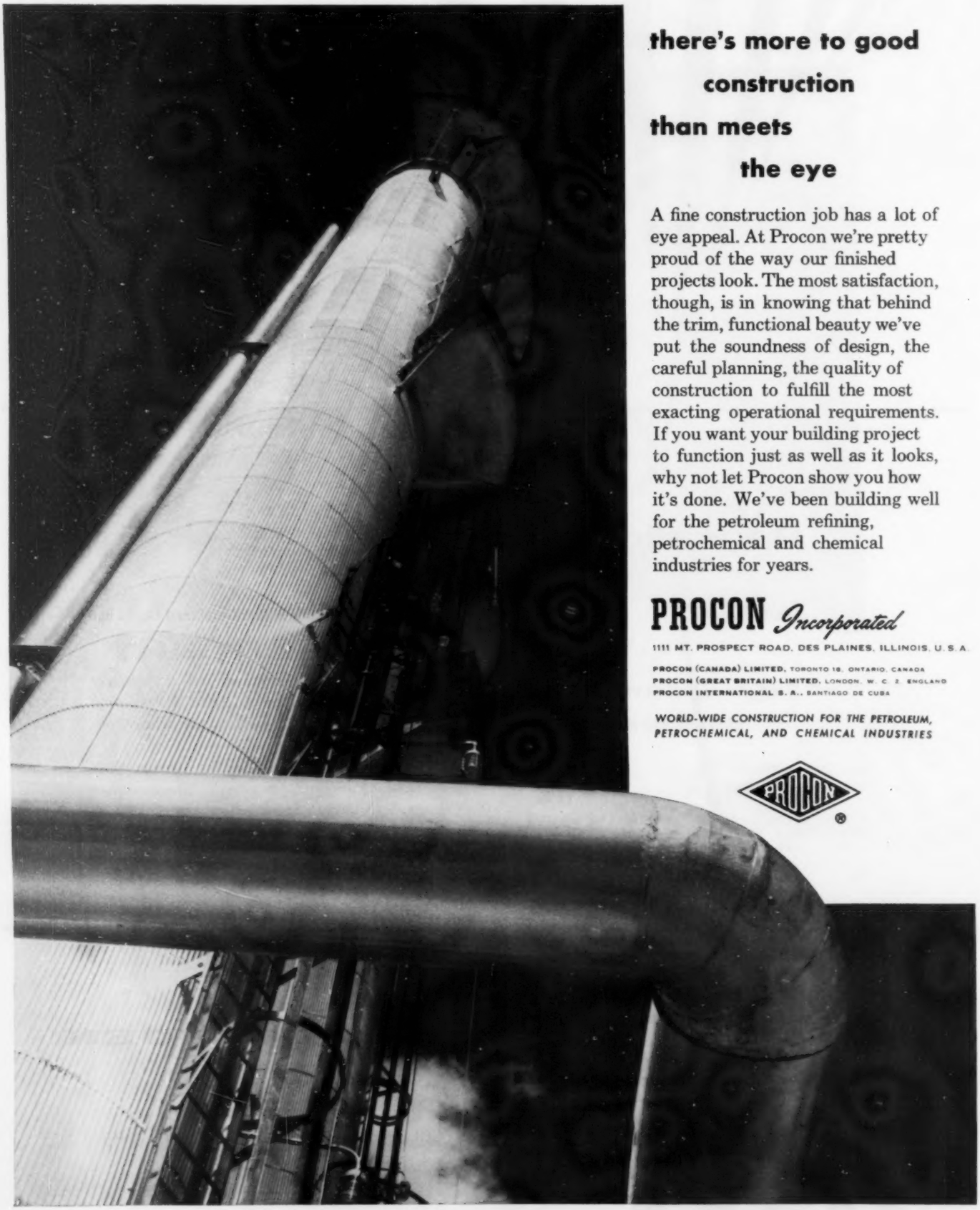

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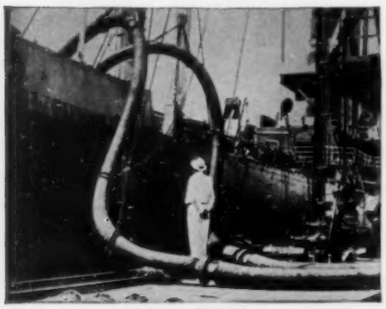

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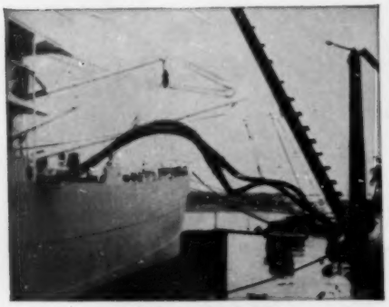

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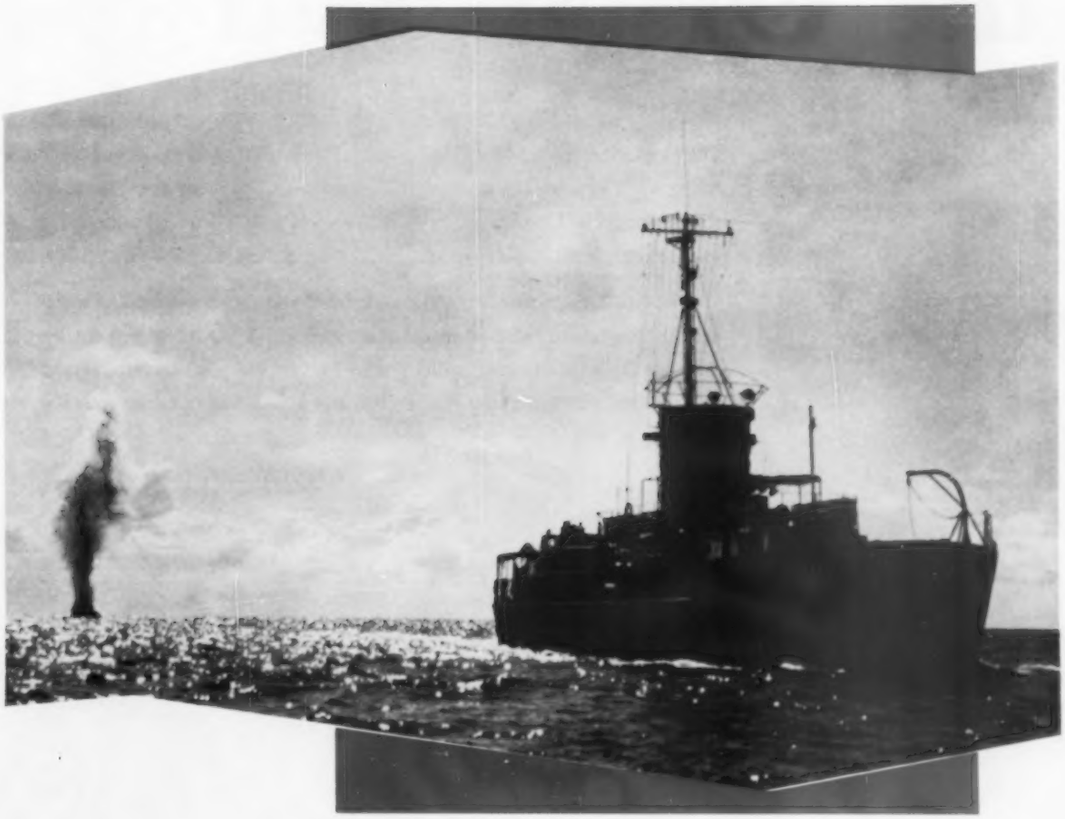

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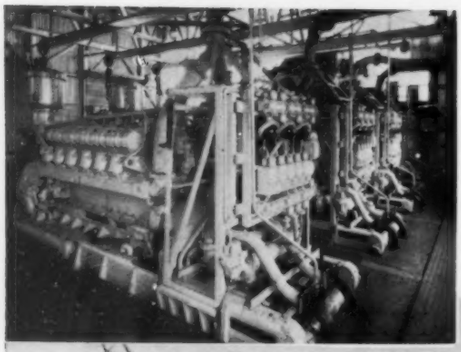
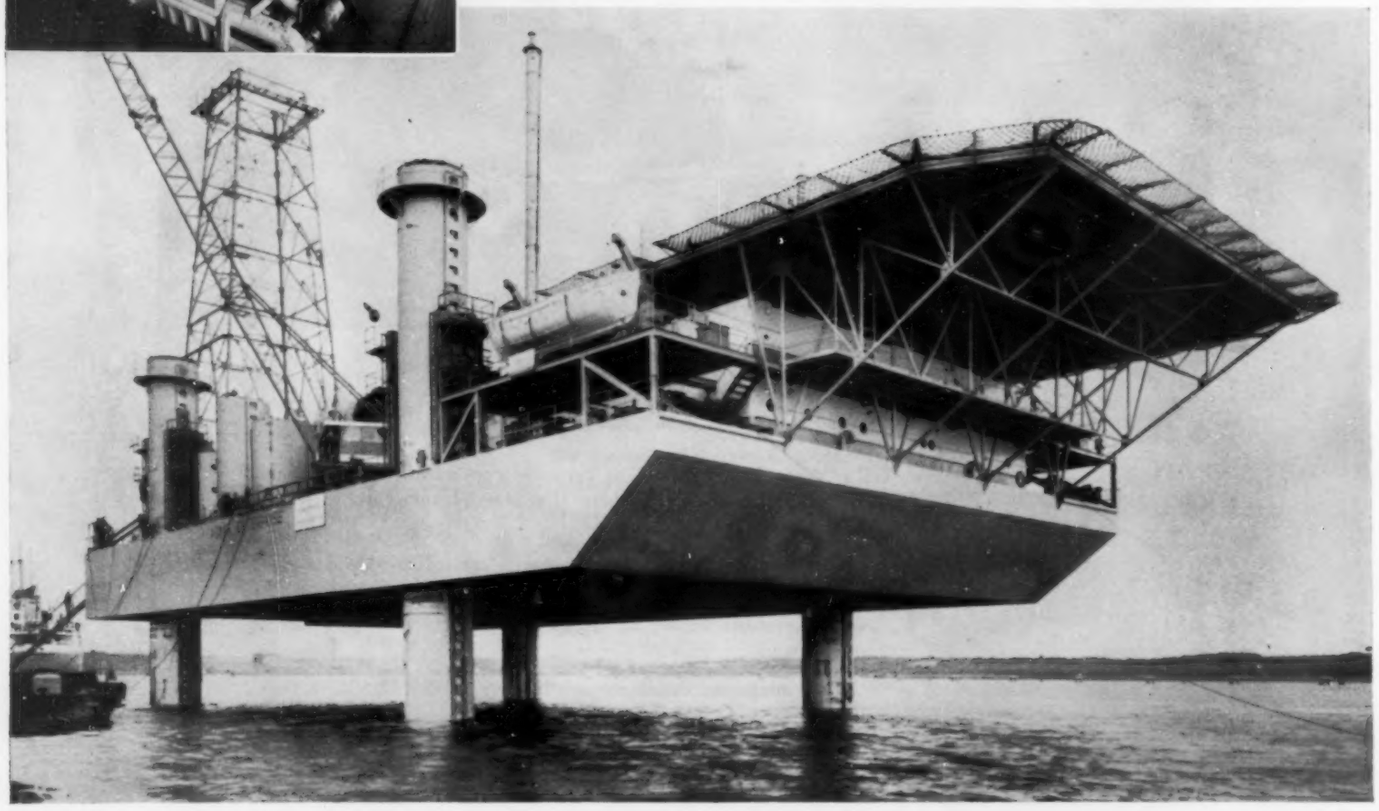


The A.D.M.A. "Enterprise", built by Gutehoffnungshutte Sterkrade A.G. for Abu Dhabi Marine Ares Ltd., has a National 130 draw-works powered by four Paxman 12 RPH 400 s.h.p. Drilpak units *(see inset)*. The drilling equipment was manufactured by the Oil Well Engineering Co. Ltd. and is capable of drilling a hole 15,000 ft. deep. The 440 volt main electricity supply is obtained from three 220kW alternators, each driven by a Paxman 12 RPH engine.

These seven Paxman units are the latest addition to an already large number operating on offshore and land installations throughout the world and emphasise, once more, that they are the answer to the driller's need for flexible and dependable power. The illustration below shows the "Enterprise" during the testing of the retractable legs. *(B.P. photograph)*



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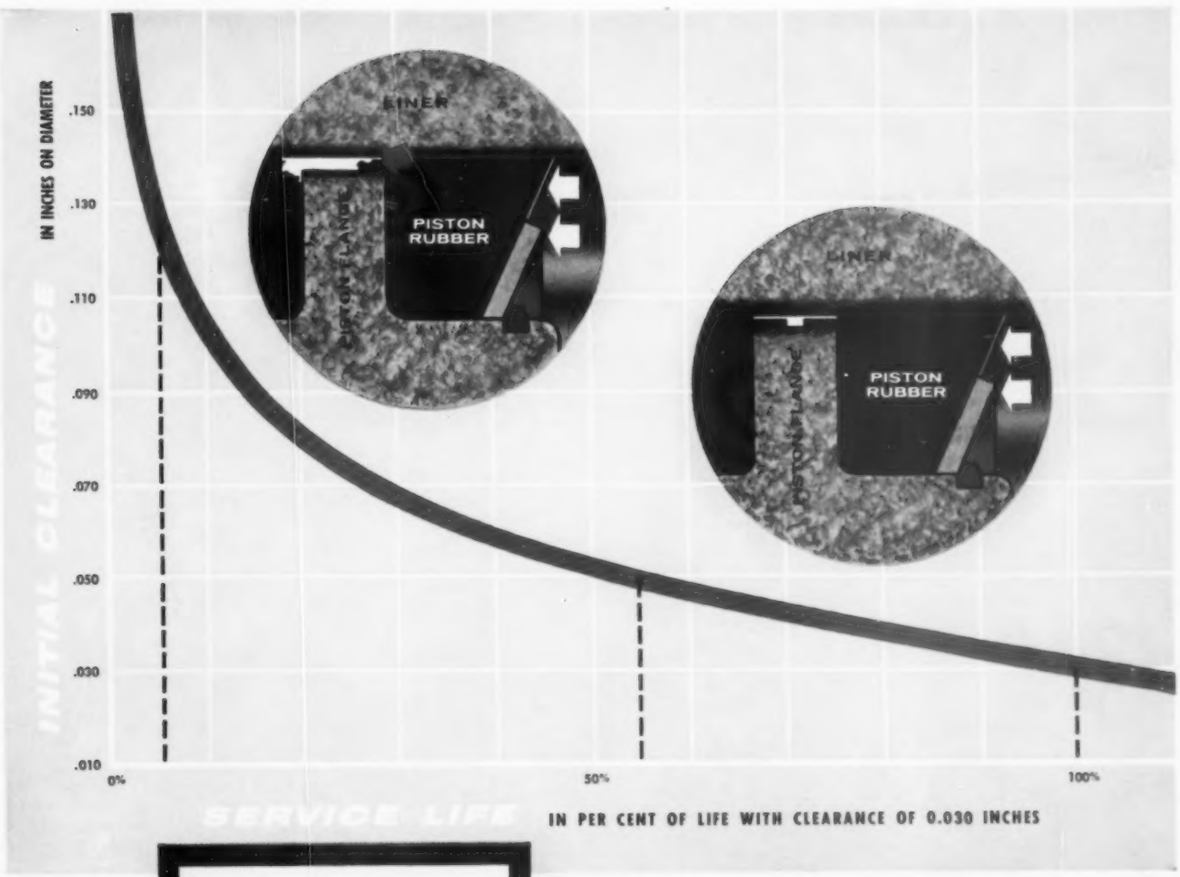

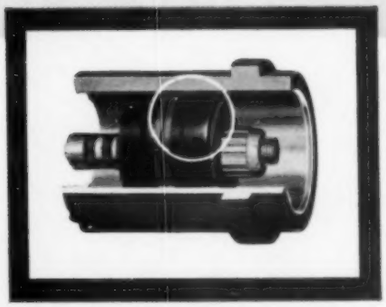

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.... from piston rubbers when Piston-Liner clearance is kept low!

THIS GRAPH IS AN ACTUAL RECORD of a series of tests run in the Mission Test Pumps. It shows just how much piston rubber life can be increased by replacing both liners and piston bodies before they are excessively worn.

For example, it was proved that piston rubber life could be increased *ten times* when initial clearance was reduced from 0.125 to 0.050. This ratio applies for the test conditions. The general principle applies in many cases—especially when pressures are high and operating conditions severe.

There is one important thing the chart does not show, however. You get closer clearances—*longer*—when you use *both* Mission Pistons and Mission Liners. Precision machining, together with advanced metallurgy and heat treating, accounts for this longer life.

Save both money and down-time by replacing pistons and liners before they are worn too much. When you do, you will make a further saving if you specify *MISSION* Pistons and *MISSION* Liners. They are available through supply stores everywhere.

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THE FIRST HUNDRED YEARS

In just a few months, the petroleum industry will note the beginning of its hundredth year from the date of the Drake discovery. From this modest start, the oil business has grown into an empire of energy... one of the vital sources of power for the needs of man.

Reviewing the past and previewing the future... one of the most important factors contributing to oil's commanding position is research – the continuous investigation to do things better. Halliburton will continue to devote a substantial share of its resources for "the better way."

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A Disservice to National Security

When members of President Eisenhower's cabinet committee recommended a "voluntary" reduction in crude-oil imports into the United States, they stated the purpose of the reduction was in the interests of national defense. "It is clear," the committee told the President, "that there is a direct relationship between the nation's security and adequate and available sources of energy. Oil and gas account for two-thirds of all the energy consumed in this country. Furthermore, there is no adequate substitute in sight for the foreseeable future. Therefore, we must have available adequate supplies of oil." The committee went on to state that foreign oil supplies are vulnerable in a national emergency.

It seems obvious that the committee was not thinking of Canada when it prepared its recommendations to the President. Canadian oil supplies are as available to the United States as are many from domestic fields. Canadian fields and pipelines are as invulnerable to enemy attack as are fields in the United States. As a matter of fact, the Canadian industry was encouraged to construct the Trans Mountain pipeline from Alberta fields to the Pacific Northwest because of the favorable effect such a line would have on oil supplies on the West Coast in time of emergency. California reserves have been falling for a number of years. Favorable drilling sites for exploration are now few and far between. At the time of the Suez crisis a year ago, California was swift to send its tankers to Puget Sound for Canadian oil which could be imported quickly without an undue burden on available tankers. Tankers were scarce when Europe's oil had to be shipped around the Cape of Good Hope, and California could not depend on supplies from Indonesia or the Middle East.

Canada and the United States have pooled their energies and resources in planning for the defense of North America against a common enemy. Early warning of attack from across the arctic region has been made possible because Canada cooperated in development of radar and airfields in the northland.

Interests of Canada and the United States are much the same in other fields as in defense. Economies of the two nations are closely linked. The United States depends on Canada for many vital commodities. What would the USA do without Canadian nickel, for example? With domestic supplies of iron ore decreasing, the Canadian mines are a much needed insurance. Certainly Canadian oil would be essential in case of war. California can no longer supply Washington and Oregon markets. The Twin Cities and Great Lakes regions with no adequate local supplies of crude would need petroleum to replace Mid Continent oil in an emergency. In both instances, Canadian oil would be safe from attack.

It seems clear, then, that the recent action in limiting crude imports from Canada into the Pacific Northwest is not in the interest of national defense. On the contrary, it is inspired solely by a desire to build an outlet in the west for Four Corners crude and relieve Texas markets of the necessity of making room for this oil. The purpose is economic—not military.

Even from the standpoint of economics, it does not make sense. Four Corners crude at present well-head prices cannot be piped to California and trans-shipped to Seattle markets in competition with Canadian oil. The only economic means would be to divert Middle East or Indonesian oil from California to Seattle to replace Canadian oil. In effect, this would mean that Canada's future ability to contribute to North American defense would be hampered by imports of Eastern Hemisphere crude. Canada, as well as the United States, needs a healthy industry and a sure reserve for an emergency.

Several years ago there was considerable anti-American sentiment in Canada because of feeling in the dominion that too much money was flowing across the border into Canadian industry. Fear was expressed that control of Canadian business was passing into American hands. This feeling subsided without legislative action to restrict foreign investment. But Canadians in all walks of life are angry today. The anger is not restricted to oil men whose market is being shut off. Political leaders are incensed because they think the action is not justified. They deny retaliation but, nevertheless, point out that Canada buys as much or more oil from the United States than she sells to the USA in the form of crude. Dollar payments are nearly in balance. Retaliation would be easy. USA crude now being refined at Sarnia, for example, might be reduced or eliminated by a tariff and readily replaced by Prairie crude.

Even more serious for the USA economy as a whole is the present reaction of the Canadian business community. A trade mission now is in the United Kingdom to see how Canada can increase its purchases in England. For many years Canada has been the best customer of United States manufacturers. It would be most unfortunate if a restriction on imports of Canadian crude into the United States in the interests of national security would, in fact, contribute to insecurity and, in addition, hurt the national economy.

World exploration hits peak

THE year 1958 will be an eventful one from the oil explorer's standpoint. Worldwide exploratory activity has hit a new high, and seems likely to continue increasing during the coming year.

During 1957 outstanding discoveries were made in Venezuela, Alaska, and Saudi Arabia. There were other interesting ones as well, such as the Maquia strike in Peru's Montaña basin, but the significant aspect was the overall total of work which has been done. Probably geophysical activity hit a new high (final figures are not available yet), and certainly the number of active rigs outside the United States and Canada did. There follows a brief review of drilling done during the past year and that in progress at present.

North America

ALASKA: Richfield Oil Corp. made a 900 b/d discovery on the Kenai Peninsula, 40 miles southwest of Anchorage, during September 1957. The well flowed 33 API gravity oil and 122 mcf gas through a 1½-in. bean. Drilled to 12,384 ft, Richfield's Swanson River Unit 1 well was plugged back and 5½-in. casing set at 12,000 ft. Production is from a perforated interval 11,150 ft to 11,215 ft. It is now producing 360 b/d. Standard Oil Co. of California purchased a joint interest, and will operate the discovery—spending $30 million on the 71,600-acre area. Richfield has an 89½% interest; the rest was held by Union Oil Co. of California and The Ohio Oil Co. A second well, two miles south, was drilling as of mid-December 1957.

CANADA: Significant oil discoveries were made in Alberta at Innisfail in the central part of the province; and at Swan Hills, Virginia Hills, Edith Lake, and Kaybob—all northwest of Edmonton.

At Virginia Hills, Home-Union-Hudson's Bay Virginia Hills 9-20 was completed at 10,624 ft. The Innisfail oil pool of west central Alberta may be one of the most significant Devonian reef discoveries of the past four years. Location is northeast of the Mississippian group of fields at Westward Ho and Sundre. Canadian Oil Companies

Loffland Bros. camp and air strip at Puerto Viejo, Costa Rica, on the Caribbean coast, where this drilling contractor is engaged in drilling a series of tests for Cia. Petrolera de Costa Rica Ltda., a subsidiary of Union Oil Co. of California. Location of the present drill site is an hour away in the Costa Rican mountains (Loffland Bros. photo).

Ltd. and The Calgary & Edmonton Corp. Ltd. are operators.

Discoveries in Saskatchewan were generally in the southeast portion of the province. The Hummingbird discovery stands out as the first Ordovician discovery to be made in Canada.

An important British Columbia oil discovery was made at Blueberry in the northeast section of the province. Also the Boundary Lake field, in the same sector, was extended considerably by a number of stepout wells.

MEXICO: Activities during 1957 continued primarily along the coastal plain of the Gulf of Mexico. Exploration in this area included an offshore seismic survey between Cabo Rojo and Tecolutla in the state of Veracruz.

Forty-six parties were active in 1957, of which 10 did surface geological work; 14 geological crews were engaged in subsurface investigations; 17 parties continued land seismic surveys; one marine seismic crew was used for 3 months; and 5 gravity-meter parties continued their reconnaissance work in different parts of the country.

In Baja California, a sixth deep test was drilled, and a seventh wildcat is being drilled in the Iray-Purisima basin. No discovery has been made.

In the states of Nuevo León and eastern Coahuila, one gas-producing field was discovered during 1957 in the Garza anticline, 20 miles northwest of Ciudad Anáhuac, NL. Production was obtained from fractured limestones of the Eagle Ford Upper Cretaceous formation at a shallow depth, and this discovery has definitely proved the production capacity of the Cretaceous calcareous formations of northern Mexico.

The most important development in the Isthmus of Tehuantepec, where production is related to salt-dome-type structures, was the discovery of the Rodolfo Ogarrio field, located 32 miles east of Coatzacoalcos. Several oil-saturated Miocene sands were encountered in the first wells and, judging by seismic and subsurface information, the field is believed to be of major importance in this area. Other discoveries in the isthmus were made from separated faulted blocks and flank production in the known salt core structures.

New field wildcats drilled during the first 10 months of 1957 were 57, and the fields discovered during this period were 10. Grouped by districts, the new fields discovered in Mexico during 1957 were:

Northeastern Mexico:	Garza
Northern Zone:	Torrecillas (gas)
	(Tampico, Golden Land and Poza Rica districts)
	Tihuatlan (oil)
	Malpica (oil)
	Gran Morelos (oil)
	Independencia oil)
	Caristay (oil)
Veracruz Zone:	Nopaltepec (gas)
South Zone:	Rodolfo Ogarrio (oil)
	Mataverde (gas)

Central America and the Caribbean

Exploratory activity in the Central American and Caribbean areas was higher during 1957 than at any time in the past, and will increase during 1958. In Central America, the most active drilling country was Costa Rica—where Union Oil Co. of California has drilled its sixth unsuccessful exploratory well. The company went across the border into Panama, and drilled another well—without success. It is currently drilling on a new structure. In British Honduras, Gulf completed two dry wells, and then withdrew the rig early in 1957—only to come back later. Shell Petroleum Co. Ltd. then acquired a half-interest in the 4,552,000 acres which now cover the northern half of British Honduras.

Two wildcat wells were being drilled at the end of the year—one at Roaring Creek, and one at Tower Hill. Shows are reported at Roaring Creek. Kerr-McGee is the driller. The exploring company announced the two rigs will be kept busy during 1958 drilling additional wells.

GUATEMALA: An exploratory well was spudded by Coastal Plains Oil Co., formerly Sloane Exploration Co., at Bananera on the Morales concession about 35 miles southwest of Puerto Barrios—using a slim-hole 7,000-ft rig. Two more wells as planned near Puerto Barrios, and others at San Felipe and El Estor. Standard of California will drill near Livingston soon. Ohio Oil plans a well at La Arruga Grande, near the Mexican border, and is moving in equipment Continental Oil Co. will drill near Lake Flores.

HONDURAS: There are two principal concession holdings in the country—one of which belongs to Petrolera Hondurena SA, which covers about 48 million acres along the north coast, with about 16 million on land, and the rest offshore. John W. Mecom acquired this concession in 1956, and drilled a dry test at Laguna Canatasca on the Caribbean coast to a total depth of 6,950 ft. Barnwell Offshore Inc. acquired a half-interest in the company during 1957, and will drill two deep wells—one offshore and one on land in the department of Gracias y Dios. The deep test first had been scheduled for August 1, 1958.

A group of Texas independents acquired about 10.3 million acres which evidently first had been acquired by Lester Foran and L. S. Holmes, also of Texas. A seven-member syndicate purchased by concessionaire company, Petroleos Hondurenos SA, consisting of Georesearch Inc., Harold D. Byrd, American Maracaibo Co., Oil & Gas Property Management Inc., Justiss-Mears Oil Co., McRae Oil & Gas Corp., and Western Hemisphere Inc. The latter was formed recently to consolidate holdings of Russell Cobb, Jr., Tulsa independent, and several associates. The company spudded a preliminary test well to 400 ft to meet a July 1957 drilling obligation. The well was downdip from an oil seep in Santa Barbara province.

NICARAGUA: The principal exploration concession, the Miguel d'Escoto-Joseph J. Coney holding, was taken over by Waterford Oil Co.—with 2/9 interest owned by Gulf, J. Ray McDermott Co., the driller (2/9), and 5/9 remaining to Waterford.

The first well, Touche No. 1, was spudded in February in 6 ft of water, about 25 miles offshore and 45 miles northeast of Puerto Cabezas on the Atlantic coast. It was abandoned at 14,998 ft, with no shows; and the company reportedly plans five to seven more wells. This was the first offshore test. Two on-land wells were drilled by Gulf Oil Corp. near Punta Gorda in 1940-41, but hit granite at about 6,200 ft.

PANAMA: Most of the country is covered with concession rights. Champlin Oil and Refining Co., acting as operator for a group including Kerr-McGee Oil Industries Inc. and Southland Royalty Co., Fort Worth, will drill two wildcats during early 1958 offshore in the Laguna de Chiriqui—one in about 120 ft of water. A preliminary survey by Geophoto Services Co. revealed sediments of about 12,000-ft thickness and numerous anticlinal structures and folds—with pronounced closure or relief. Union's difficulty some 30 miles away, in its Costa Rican discovery, was lack of adequate structure for oil accumulation, although oil sands were found.

International Oil and Metals Corp., a combination of mining interests from the USA Pacific Northwest, acquired about 10 million acres from Cia. Petrolera del Golfo del Darien, affiliate of World Commerce Corp., New York. A shallow test, with no shows reported was drilled early in 1957.

Tradewinds Exploration, subsidiary of McRae Oil & Gas Co., obtained considerable acreage through farmouts during the year.

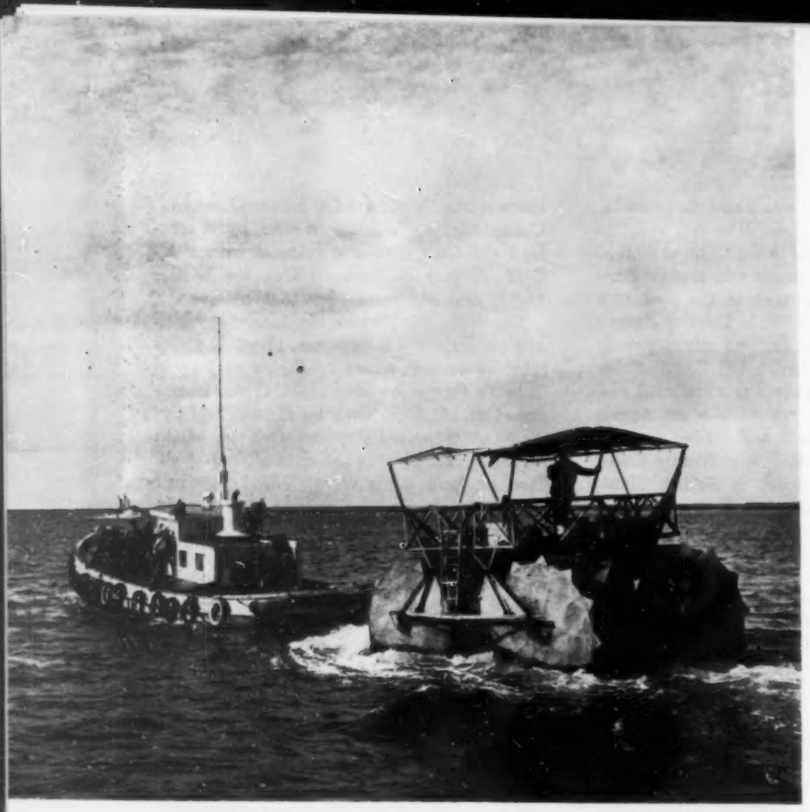
The Caribbean area slowed down during 1957, and seems likely to slow down further during 1958.

John W. Mecom interests drilled a dry hole in Haiti, and pulled out the rig. During 1956, Mark Edwin Andrews, independent oil producer of Houston, had completed his second and third tests—both dry. No favorable reservoir characteristics were reported in the sediments penetrated. Mecom likewise reported no shows in his well in Haiti. Commonwealth Oil Co. has remained interested in possibilities in the island. The Texas Co. began surface geological mapping in southern Haiti late in 1956. No wells are known to be contemplated.

Pan Jamaican Oil Co. has drilled four dry wells, and so far has not obtained production in Jamaica. The latest well was at Negril—abandoned at 9,244 ft., with no shows. Pan Jamaican has now abandoned its search.

Cuba continued its intensive exploratory campaign without any positive results. The Bahamas Islands have not seen another exploratory well as yet. Trinidad made no major exploratory news during 1957. However, an interesting well is drilling, Couva Marine 1, by Dominion Oil Ltd., offshore.

Interest revived in the Dominican Republic during 1956. There are some active oil and gas seepages in the Azua and En-



Crew boat and swamp buggy form a tandem as storm warnings predict a "norther" in the Gulf of Mexico. These units of the Cities Service Co. seismic party are headed for more protected waters, there to wait out the storm (photo by Fritz Henle for Cities Service).

Assistant Surveyor Ray Drost (left) and Surveyor Red York run a line of shot holes in the sagebrush and alkali grass country of Wyoming's Whisky Peak area (photo, courtesy The Sohian, *house magazine of Standard Oil Co. of Ohio).*

riquillo valleys. Petrolera Dominicana CA, a syndicate of independent USA oil men, includes H. S. Cole II, Albert D. Fay, and Floyd Odlum, president of Atlas Corp., as stockholders. The company received a 2.1-million-acre exploration permit in the Cibao valley. A drilling rig is moving in. Pohly Exploration Co. of Tulsa did gravity work for the company early in 1957. A shallow well is being drilled by Azuana Petroleum at Azua.

Puerto Rico is showing signs of oil activity also. A 64,000-acre concession was granted to William S. Wallis, of Toronto, and F. H. Crerie, of Houston. General geological work has been carried out.

Gulf Oil Corp. has drilled five dry holes —two of them gassers—in Barbados. The sixth well is now being prepared. A new and operable oil law was passed in January 1958.

TRINIDAD: Dominion Oil Ltd., wholly owned by Standard Oil Co. of California, is drilling a wildcat well offshore from Trinidad. The wildcat, which is referred to as a stratigraphic test, is called Couva Marine No. 1, and is being drilled in 40 ft of water, 4½ miles off the west coast of Trinidad, about 13 miles south of Port of Spain. No shows have been found, despite rumors of discovery. It is quite far to the north of Trinidad's only offshore field so far, Soldado, which now has three producing wells, one of them a dual producer. Dominion holds about one million acres, both offshore and onshore in this area.

CUBA: Atlantic Refining plans a series of eight test wells—at least four of which will be deep holes. The Texas Co. has finalized its agreement with Gulf which will result in four deep-test wildcats in Las Villas province in central Cuba. Stanolind has begun drilling two deep tests off the south coast. Shell spudded a deep test off the north coast, near where it drilled more than 10 years ago. Partners with Shell in the venture are Standard of New Jersey and Atlantic Refining. Standard of California has had field parties working off the north coast. Kewanee, an independent, has started a deep wildcat on a Gulf farmout.

South America

Activity concentrated on upper South America during 1957, as Argentina, Brazil, Chile, and Uruguay remained closed to private capital. Interest heightened in Paraguay and Bolivia—both newly opened to private capital—and in Peru, where a new strike in the Montaña region gave first encouragement there. However, no deep sedimentary basin has yet been proved in Peru.

Ecuador also seems due for a more intense oil search. Recently, also, Surinam granted a concession to the Colmar Surinam Co., but oil prospects there seem remote since a Jersey Standard wildcat many years ago encountered metamorphics at shallow depths.

Interest centered on Venezuela and Colombia, where new discoveries were made in 1957, and on the Gulf of Paria between Venezuela and Trinidad.

BOLIVIA: Increased interest during 1957 brought the concession holdings by Shell Prospection, a subsidiary of Shell Oil Co.; Bolivian Gulf, owned 80% by Gulf Oil Corp., 20% by Falcon Seaboard Drilling Co., Williams Bros., and Barry & Reiner Inc.; The McCarthy concession [taken over under option from the government by TULM Corp., owned by Tennessee Gas Transmission Co. (35%), Union Oil & Gas Corp. (25%), Lion Oil Co. (25%), and Murphy Corp. (15%)]; Andes Oil Co., owned equally by Pure Oil Co., Standard Oil Co. (Ohio), and Hancock Oil Co.; and White Eagle International Oil Co., Blackwell Oil & Gas Co., and Western Hemisphere Petroleum Corp.—all of Tulsa.

Bolivian Gulf is drilling a wildcat at Boyuibe, Santa Cruz. Site is north of the Marareti test, in the Mandeyapecua area.

During 1957 bids were invited by YPFB on the Yacuiba area, some 108,000 acres which overlap the producing Madrejones structure in Argentina.

Another company, Cataract Mining, reportedly acquired acreage in Bolivia through Lombardo Bros.-Kiel partnership. Cost was $1.5 million. Location is not known.

BRAZIL: During 1957, 44 wildcats were drilled of which 11 were in the Amazon basin, 7 in Maranham, 5 in Sergipe-Amagoas, 18 in Bahia, and 3 in Parana-Sao Paulo. 34 stratigraphic wells were drilled, and the total of wildcat plus stratigraphic reached 441,155 ft, compared with 134,829 ft in 1956.

The best discovery to date, No. 1-AZ well at Nova Olinda, proved less productive than had been expected, and was shut down while offsets were drilled. The second offset, No. 2-AZ, was about ½ mile away. It found oil and gas, and yielded 1,450 bbl under test, with diminishing pressure, until about May 26 when it dropped to 10 b/d due to accumulation of paraffin in the tube. Three more wells are drilling in the same area.

Off shore wildcat DJX-1-BA, an extension of the Dom Joao field in All Saints Bay, was brought in as a producer early in August. Oil was found at about 1,000 ft. A yield of 100 bbl was obtained in the first 2-hour test.

Oil and gas shows were obtained in August at 7,208 ft from JA-1-AL on the Jequía River, 24 miles southwest of Maceio, Alangoas, where drilling had been started on March 20. The horizon between 5,089 ft and 5,100 ft increased from average to extremely strong pressure in 11 min through a ¼-in. choke. Yellow-greenish oil, with high gas pressure, flowed 125 b/d of 41 API crude.

Petrobras' announced well SP-1-BA, at San Pedro, found porous arenite, oil-saturated, at 5,691 ft. Formation test gave a "good" oil flow of light crude. Similar shows were found in the 3,221-ft to 3,273-ft interval. This well is near the producing fields of Bahia, and may indicate an extension of this area.

CHILE: ENAP (Empresa Nacional de Petroleo) extended activities to the northern province of Tarapaca. A total of about $1.5 million is to be spent on this area between now and the end of 1958.

Drilling was up during 1957—with a total of 19 oil wells, 9 gas wells, and 26 dry holes completed during the first 10 months, compared with 18, 16, 30 during all of 1956.

COLOMBIA: About 15 wildcat drilling rigs are operating. A major development during 1957 was the discovery of Gualanday No. 3 in the upper Magdalena valley by International Petroleum Co.'s subsidiary, Intercol. The well, on a three-day test, flowed 840 b/d of 38 API crude on a ⅝-in. choke. It is 15 miles west of Giradot and 75 miles southwest of Bogotá.

On the Caribbean coast, John W. Mecom, Texas independent, abandoned his 25-75 agreement with Ecopetrol.

Shell is reported to have brought in Las Garzas wildcat on test for several hundred barrels daily, having drilled it to 10,012 ft. Just north of this location, Intercol completed at No. 35 its Mata 1, having drilled it to 9,663 ft, as a noncommercial producer.

ECUADOR: No exploratory discoveries were made during 1957. Shows were found by California Ecuador Petroleum Co., Socal subsidiary, in No. 1 Santo Domingo wildcat. About 10 miles west of California Ecuador's wildcat, West Pacific Petroleum Co., subsidiary of Israel Mediterranean Petroleum Inc. and Pan-Israel Oil Co. Inc., has taken a concession. Several companies have offshore rights, and California Ecuador is doing offshore seismic work on its area. Anglo Ecuadorian is doing directional drilling from the shore of its Ancon concession which extends 1.5 miles out to sea and 45 miles along the coast.

PARAGUAY: Recently the government opened the entire Chaco area to exploration. The largest concession granted so far was to Pure Oil Co. Pure must drill 15,000 ft and invest $1.5 million within 20 months; begin work within eight months; invest 10 cents per acre yearly for four years. After 20 months, company can surrender all or part of area. 50% must be surrendered from 3rd to 6th year, and 75% by 10th year—leaving about 3,750,000 acres. Taxes are limited to 50% of net. Royalty is 11%.

PERU: Outstanding development was discovery in Peru's Montaña region of about 500 b/d production in Maquia No. 1 in March 1957, by El Oriente Co., associated with a syndicate of three German companies, Deutsche Erdoel, Wintershall, and Elwerath—one of them partly owned by Jersey Standard. The well is on a southeast-northwest trending structure in the Tertiary red beds. Three previous wells were dry. The Maquia well was dry at 5,323 ft in the Agua Caliente sandstone of Lower Cretaceous age. Plugged back, the well yielded about 500 b/d of 38 API crude on a ¼-in. choke from 2,139 ft to 2,162 ft. Bottomhole pressure was about 190 psi. A second well produced about 600 b/d. Three offset wells are being drilled.

Twelve previous wildcats drilled in the Montaña region of Peru's Amazon basin were dry, and no deep sedimentary basin has been proved as yet in the region.

VENEZUELA: Exploration is centering around three principal areas, viz., Lake Maracaibo, Gulf of Paria, and in the extreme west of Venezuela along the Colombian border.

Lake Maracaibo: Superior's first well, No. 1 Lama—located in the northeast corner of its concession—found 313 ft of oil sands in the C4X and C5X Eocene series. The well went to about 8,000 ft. With 9⅝-in. casing set at 7,982 ft, the well was completed in a 65-ft section of the C4X from 7,425 ft to 7,490 ft, and in a 105-ft section of C5X from 7,652 ft to 7,757 ft. It tested 5,000 b/d through a ¾-in. choke. The second well, No. 5 Lama—located 2½ miles south of No. 1—logged 350 ft of oil sands in Eocene between 7,400 ft and 8,000 ft. Two more wells, No. 6 and No. 7 Lama, soon followed to complete tests on this western half of Group 75 area. No. 5 and No. 6 tested about 7,000 b/d on a ¾-in. choke. Superior promptly drilled an outpost to No. 2. Lama No. 7 found 500 ft of oil-saturated sand in the Eocene between 7,000 ft and 9,000 ft. Altogether, these lake discoveries indicated a lucrative oil find.

A second major discovery was made in the lake by Venezuelan Sun Co.—operating for itself, Seaboard Oil, and Atlantic Refining. Sun's first well, No. 1 SVSX, went to 13,700 ft and discovered some 500 b/d production in the Cretaceous from 11,050 ft to 11,074 ft.

Early in December, Venezuelan Sun made an important discovery when it completed No. 5 SVXS on the 24,710-acre tract—testing 7,080 b/d of 32 API crude through a ¾-in. choke from a 100-ft section of Eocene between 9,470 ft and 9,570 ft. With about 900 ft of productive sands, the well's total depth is 9,693 ft.

Signal Exploration Co. spudded an exploratory well in Lake Maracaibo during mid-1957, No. 1-X Centro Lago. Though abandoned at 9,470 ft, some oil shows had been found. Signal made a later major discovery, Centro 2X, which flowed 2,400 b/d of 40 API crude through a ⅝-in. choke—during October 1957.

Middle East

Exploration in the Middle East during 1957 was dominated by new exploration concessions received in the Neutral Zone, and in Iran by the Japan Petroleum Export Co. and Ente Nacionale Idrocarburi, respectively. New trends are indicated in established distribution of profits between government and company. Both these contracts were concluded by companies not having sufficient financial resources to put up a large initial bonus payment, but which were willing to give substantial concessions to the governments concerned in order to gain a foothold in the Middle East. In any event, their contracts enabled them to explore for relatively small cost. The contract obligations call for substantial outlays only when production has been found.

(Continued on page 102)

Geophysical crew's Sahara camp site: Seismic weight-dropping field equipment is in background; foreground (left) shows mess hall and water truck; crew living area (in tents) is at right.

Sahara seismic operations

by Alan D. Waldie*

SINCE 1946, when seismic prospecting began in the Algerian Sahara, many new geophysical techniques and procedures have been devised. The recent introduction of the weight-dropping technique in Algeria promises to be an important aid to Saharan operations.

By the end of 1957, a total of some 20 seismic reflection and refraction crews (including two weight-dropping crews) and three gravity crews were in operation throughout the Sahara. These crews were working on permits covering about 280,000 square miles—out of a possible 850,000 square miles—in a territory made geophysically complex by variable surface formations of hard and abrasive limestone or caliche, by an ill-defined water table, and also by the ever-shifting sand dunes.

The main impetus for increased seismic activity in Algeria has come from recent estimates of a potential of some 1.4 billion barrels of crude oil which lie underneath these desolate wastelends of the Sahara desert. This information is based on data taken from 32 wells, which have now been completed throughout the area.

Most common techniques not helpful: It was found from experience as early as 1953 that the conventional methods of seismic shooting crews, which were usually successful in other areas, would not give the desired results in the Sahara. For example, the first attempts to get records by using deep shot holes down to around 300 ft or more were generally unsuccessful because, more often than not in the desert, the geophysical signal generated by the shot at this depth was obliterated by noise created by horizontal reverberation from near-surface formations of limestone or caliche and thick sandy beds which rest upon more compact formations. These factors, plus the prohibitive costs of this type of operation—which are due to the difficult drilling conditions and the shortage of water—necessitated the development of newer and more effective techniques.

Since a low signal-to-noise ratio is the rule rather than the exception in this desert, a high multiplication factor (number of phones per trace times the shots used in the pattern) must be used to obtain seismic records of usable quality. In some areas (as around Hassi-Messaoud) up to 100 shots per pattern and 108 phones per trace are now being used to obtain readable records. A sketch of such a layout is shown in Fig. 1.

The shot holes used in an operation of this nature are usually drilled to depths of 3 ft to 6 ft by special air drills developed for high production and portability. One of these drills is shown in Fig. 2. This unit,

ALAN D. WALDIE, chief engineer for McCollum Exploration Co., Houston, was graduated from Texas A & M College in 1951 with a B.S. degree in electrical engineering. After two years as a U. S. Army Signal Corps officer, he joined McCollum in 1953. Mr. Waldie is a member of the SEG and IRE.

*Chief Engineer, McCollum Exploration Co., Houston, Texas.

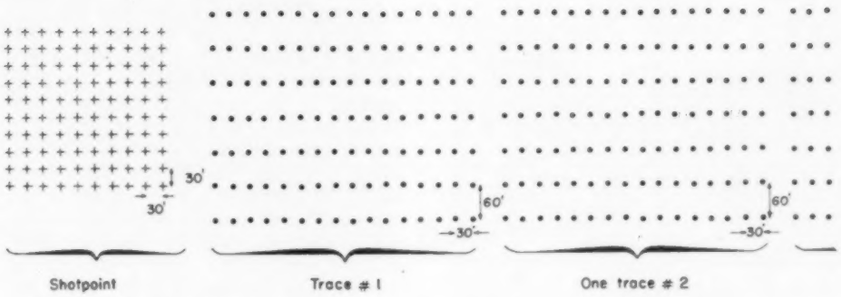


Fig. 1 Sketch showing type of shot pattern used in the Sahara.

which works on the pneumatic-hammer principle, can drill between 20 to 30 shallow holes per hour, depending upon the rock conditions of the subsurface.

Special consideration to layout distance between shot holes, and also between geophones, must be given to assure maximum noise cancellation. The distance between shot points in a pattern (Fig. 1) should be at least 30 ft or more, while the distance between geophones set out for each trace should be 30 ft or more in a longitudinal direction, and 60 ft or more in a transverse direction. It was found that this method obtains the best results from a given number of geophones and shots.*

In the Sahara, it is possible to combine low-frequency signals recorded over distances of 300 ft without too much attenuation due to moveout phase relationship. It has been proved that a proper filter setting allowed a considerable increase of distance between traces and shot points; shallow shots developing low frequencies are favorable to that setting. Without low-frequency filters, seismic reflections in the Sahara would be almost impossible.*

*Paper presented by M. Pieuchot (Compagnie Generale de Geophysique) at SEG convention, November 1957.

Weight-dropping technique introduced: When the aforementioned problems, such as the need for a large number of pattern shots and geophones (required for a high multiplication factor) were considered, it became evident that the introduction of the weight-dropping technique to desert operations would be an important aid to the geophysical exploration program. The desired multiplication factors can be easily and cheaply obtained by using the weight-drop method which generates the seismic energy by multiple impacts of a large weight dropped on the surface in a predetermined pattern without the need for shot holes or explosives. A device of this nature is shown in Fig. 3.

Weight-dropping experiments began in the Sahara in the summer of 1956. After these first experiments had proved to be a geophysical success, by comparison with standard reflection records obtained by seismic shooting crews, commercial dropping began late that summer, and has continued through 1957.

Last December, the first geograph weight-dropping system was installed under contract to two French oil companies through Compagnie Générale de Geophy-

Fig. 4 Hassi-Messaoud MD-1 well, which produces 2,000 b/d of crude at 10,000 ft: Seismic weight-dropping (Thumper) unit is in background.

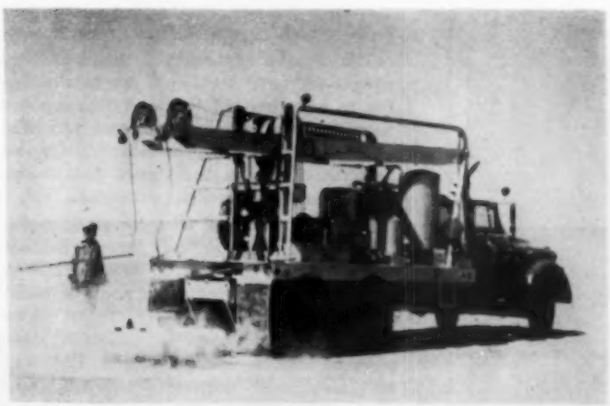
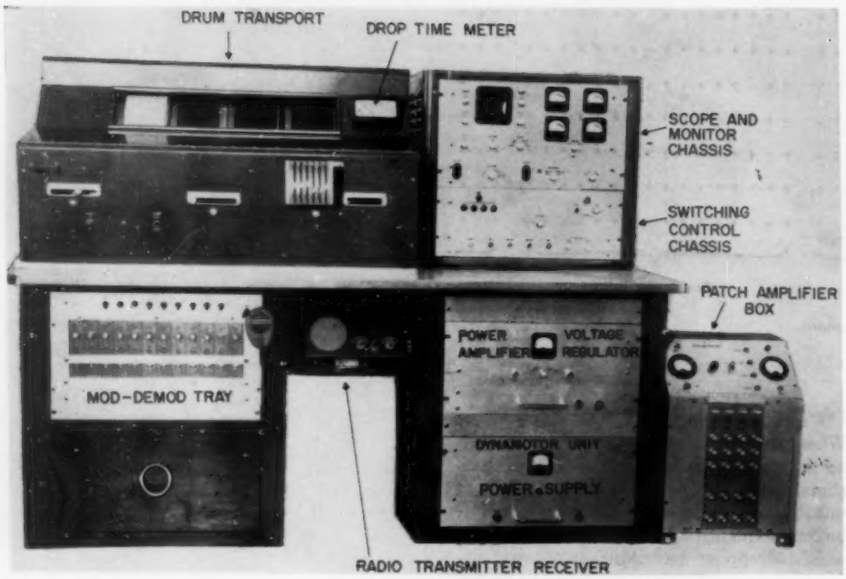
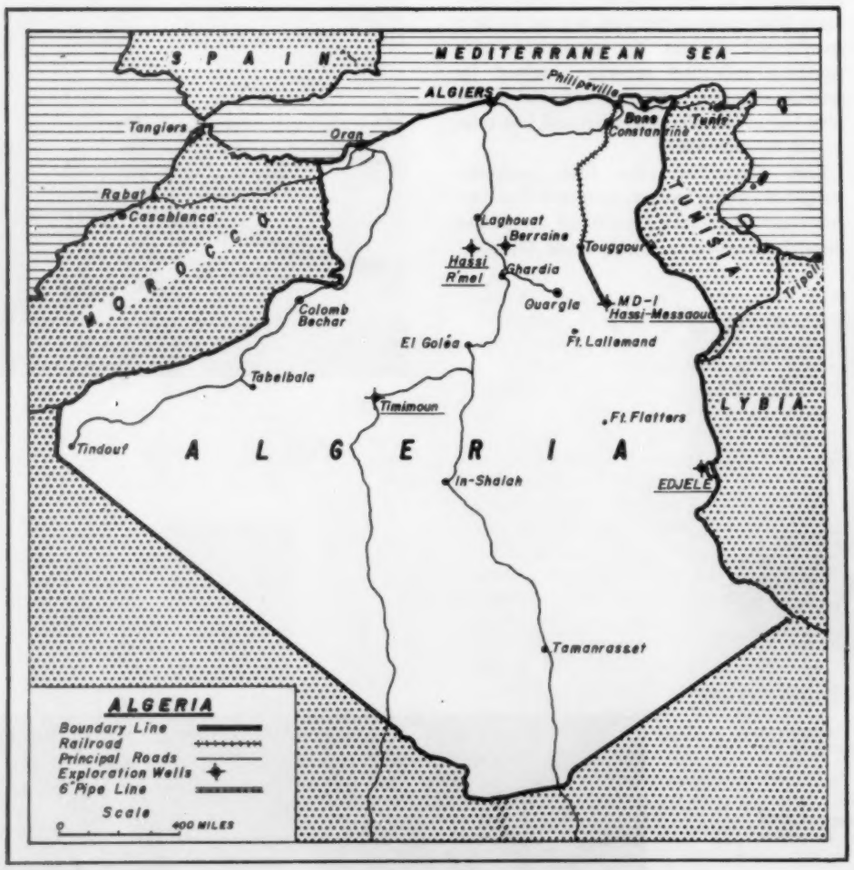


Fig. 3 Above: seismic weight-dropping device, in which a three-ton weight strikes the ground to generate seismic signal in the Sahara.

Right: Air "box-car" transport: 80% of the necessary oil-field and geophysical prospecting supplies are brought to remote desert locations by this means.



Geograph field recording instrument, when mounted in a suitable field truck, is capable of magnetically recording weight-drop seismic information from four separate detector stations.



sique and McCollum Exploration Co.

The weight dropper (thumper) shown in Fig. 4 is designed for rapidly transporting the large 3-ton weight from one drop position to the next as it simultaneously hoists this mass to a height of about 9 ft for the drop. At a time determined by the observer who operates the specialized tape-recording instruments from another truck, the weight is dropped by radio. The resulting impact generates the seismic signal into the ground. This signal is received by several detector stations spaced along the profile for proper subsurface coverage. The number of phones used per detector station varies with the area being surveyed, but generally about 208 phones are used in a series of parallel arrangement per station, and up to four stations are used at a time. In some cases the number of phones has been increased to 360 per station to increase the multiplication factor.

Successive drops are made in about 12-sec intervals—the time determined mainly by the distance selected between drops. Each drop is sequentially recorded on a multi-drum tape recorder, which simultaneously records the information from the detector stations. Then these field-recorded tapes are sent by air to Algiers, where a central-office playback machine is installed to process the seismic information into corrected seismograms for interpretation.

General-office processing: The central-office machine (Fig. 5) is a form of analog computer designated to correct the field tapes for both static (weathering, dip, elevation, etc.) and dynamic (normal move-out) corrections. This is necessary in order to time-align the recorded seismic events for integration (compositing) of these events from multiple drops to improve the signal-to-noise ratios for record quality. The final corrected drops recorded are photographed by this analyzer with a special synchronous camera which completes the seismogram as part of a record cross-section corrected to a preselected datum plane. The individual records (if desired) may later be put together for a complete cross-section of the line under survey.

The flexibility and versatility of the weight-dropping technique are now proving to be a big aid to geophysical operations in the Sahara, in the same way this technique has already been an aid for the past four years in the United States and for the past two seasons in Canada.

Problems of desert transportation: Since the centers of production are so widely scattered, the distances to be covered—as well as the scarcity of water and the instability of the sandy soil—create an acute transportation problem for almost all geophysical and oil operations. For 1957, the supplies needed for oil prospecting and production alone were more than 10 million useful tons per mile of road traveled, and it is estimated that this will be doubled in 1958. Normally, 90% of this material should go by road. At the present time, however, the road system in Algeria is insufficient to sustain transportation needs

in the desert. The road system of Algeria covers 516 miles of national roads, 7,776 miles of principal tracks, and 8,295 miles of secondary tracks without highway or paving. (The total area of Algeria is about 850,000 square miles.)

At present, air transport appears to be the most satisfactory means in the desert region. Regular lines run between principal cities carrying personnel and about 80% of the necessary supplies. (Air time from Algiers to Hassi-Messaoud is about 2½ hours, while the same distance covered by road requires 5 days.) However, airlines are costly to run, and the airplane does not do away with the need for developing more ordinary means of transportation, especially for heavy material and supplies.

Arab rebellion complicates operations: The Algerian rebels, who had been patiently and secretly planning their actions for several years, launched the rebellion on the first of November 1954, and the battle with the French and pro-French Arabs has been raging off and on ever since, at an estimated cost to the French government of about four million dollars a day. The Associated Press recently predicted that the rebellion promises to make North Africa one of the world's bloodiest trouble spots in 1958.

In November 1957 the first incident of this rebellion against the oil operations there occurred at Timimoun (see map) where a CPA (Dutch Shell) gravity crew was completely destroyed by the rebels—killing 12 members of the crew along with several guards. Since this incident, the French army has placed several thousand paratroopers throughout the Sahara to insure greater protection to the oil-field personnel and prospecting crews working there.

Oil Exports: The biggest problem which yet remains is that of successfully getting the oil out of the desert for export. At present, one 6-in. pipeline has been completed and is in operation from MD-1 well at Hassi-Messaoud north about 160 miles to Touggourt, the nearest railroad. The crude goes by rail to Phillipeville on the coast, where it is then placed in tankers for export. It is expected that an $80 million 18-in. line will be laid this year from Hassi-Messaoud direct to the Mediterranean coast.

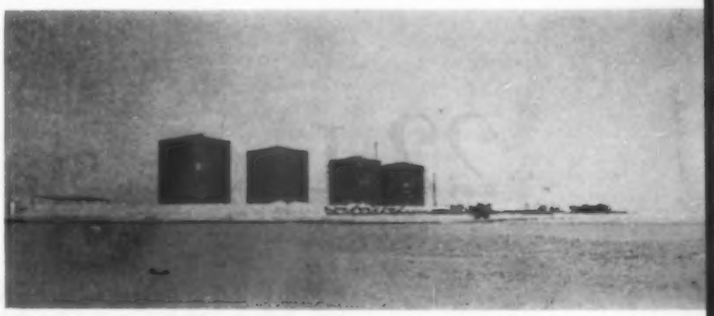
Future Prospects: With continuous progress being made in geophysical methods toward the development of special techniques for faster pattern shooting, and with weight-dropping methods for faster, cheaper, and safer productive techniques to achieve better seismic records through specialized tape-recording systems and central-office processing methods, many new "geophysical finds" will undoubtedly be made to bring the proof, through drilling, that the Sahara can be considered henceforth an "oil-bearing province."

ACKNOWLEDGMENT

Our thanks to Compagnie Générale de Geophysique (CGG), to Gouvernment Générale de l'Algérie, to Compagnie Française des Pétroles en Algérie (CFPA), to Compagnie d' Exploration des Pétroles (CEP), and to the American Consulate of Algeria —Economics Department, who helped make this article possible.

END

Fig. 2 Pneumatic shot-hole drill, which works on the jack-hammer principle, is capable of drilling 20 to 30 shallow holes per hour in Sahara operations.



Hassi-Messaoud tank farm, where oil is stored from nearby wells before being pumped through a 6-in. line to Touggourt, nearest Algerian railhead.

Fig. 5 Central-office analyzer: This complex playback machine processes the magnetically recorded seismic weight-drop records for move-out, weathering, elevation, and dip corrections before making the photographic seismogram of integrated drops for interpretation.

Attached to buoys, geophone cable is floated out behind Cities Service Co.'s recording boat in the waters of Breton Sound, an arm of the Gulf of Mexico (photo by Fritz Henle for Cities Service).

22 Lorac stations guide seismic surveys in Gulf of Mexico

by James W. Calvert

A FEW months ago, during the height of a vicious "nor'wester" which swept the coastal area of the Gulf of Mexico, radio operators were electrified by the universal cry of distress: "May Day!"

Instantly, all commercial radio traffic was silenced while Coast Guard operators frantically pleaded with the sender of the distress call to give his position.

Then came a message from far out in the storm-lashed gulf: "Plane is down at longitude (blank), latitude (blank). We are standing by."

The caller identified himself. He was a geophysical survey boat, hove-to, waiting for the storm to abate. The survey crew had observed an airplane fall into the sea; and, although unable to go alongside to rescue the airmen, was at least able to plot its position and guide rescuers to the scene of the accident.

The weather was too bad for planes to fly, and for more than 24 hours the survey boat stood by the "ditched" airplane, giving precise positions reports at regular intervals.

This information was provided by the operator of a Lorac installation aboard the survey boat as he converted the radio coordinates peculiar to the Lorac system into the more commonly known coordinates of latitude and longitude.

Thus mariners were introduced to a system of electronic navigation which has been the backbone of geological exploration in the submerged oil fields of the Gulf of Mexico since the passage of the Tidelands Act by Congress early in the Eisenhower administration. LORAC, which is simply a contraction of the words LOng Range ACcuracy, is one of the systems of positioning developed since World War II,

upon which the offshore petroleum industry has come to rely in locating seismic operations and, in many instances, in determining the precise location of wells.

The need for such a system is obvious. The potentially rich submerged oil and gas fields of the Gulf of Mexico stretch from Brownsville, Texas, on the west to the west coast of Florida on the east, and extend as far as 100 miles or more seaward. According to geophysicists, the limits of accuracy for surveys must be plus or minus 150 ft at the 100-fathom curve and plus or minus 60 ft at points closer to the shoreline. Officials of Lorac Service Corp. boast that their record is far better than that.

Inaccurate and unreliable methods of "dead-reckoning" presented seismograph surveyors and oil companies with a definite obstacle during the early geological surveys in the Gulf of Mexico. One of these companies was Seismograph Service Corp., of Tulsa, which—shortly after World War II, when interest first began growing in the Gulf Coast region—was involved in an offshore survey project.

There was no adequate system then available for precise positioning. There were only visual methods, such as dead-reckoning and radar—and both of these methods were good only to horizon distance, or line of sight. It was established procedure to set a transit onshore near a triangulation point and then tow a wire line to sea, relying upon the skill of the boatman at the helm to steer a correct compass course and, at the same time, compensate as accurately as possible for wind and tide action.

This method was fairly satisfactory so long as seismic work was confined to areas within visual distance of known reference points. Surveyors were hindered, of course, by rough seas and foggy weather, both of which invariably resulted in expensive "standby" days. Radar fixes could be plotted of know objects onshore; but this, too, was useless if the survey extended beyond horizon distance of the objects. As the scope of work extended beyond the sight of land, it became apparent that optical methods of positioning, as well as radar, were useless.

Among the first to recognize the need for more accurate offshore positioning were Gerald H. Westby, president of Seismograph Service Corp.; and Dr. J. E. Hawkins, director of the company's research department. Working from a basic patent for phase comparison held by a Frenchman and patented in 1938, the two developed what they considered a workable system for radio positioning. The system was field-tested in 1952, and the first installation was set up in the Morgan City area.

Since then the system has expanded rapidly until now it consists of 22 land stations—3 in Florida, 10 in Louisiana, 9 in Texas—and has maintained mobile receivers aboard as many as 45 seismic survey vessels at one time.

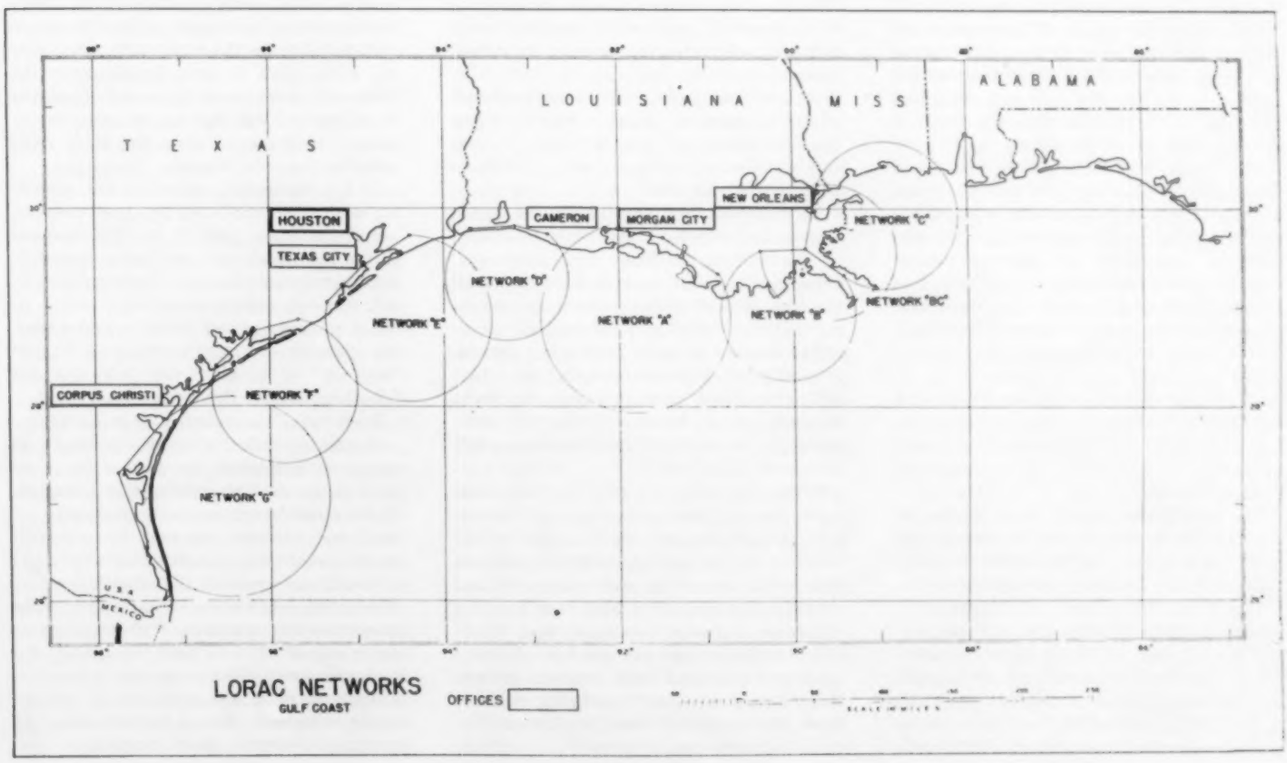
Lorac is simply a system of measuring the phase difference of the radio waves received from two continuous-wave transmitters located on land. The point where the two lines of position cross is the location of the vessel at any given time.

A network consists of three transmitting stations, viz., central, green (left), and red (right). Since radio waves travel at a constant speed of 186,000 miles per second, the speed of light, it requires merely a measurement of time between the transmitting and receiving station to determine the distance between these stations and the vessel at sea.

And now for the technicalities: The transmitters are operated on two frequencies which differ by an audio frequency. A reference signal is established by detecting the heterodyne beat between the two transmitted signals. This detection takes place at a fixed point and, therefore, has a constant phase angle. The reference signal is transferred to the mobile receiver by modulating a third, separate transmitter. The direct-heterodyne and the reference-heterodyne signals at the mobile receiver are compared, and the angle between them is measured. This angle indicates the position of the receiver with respect to the fixed transmitters.

Basically, a single phase-angle measurement would not be sufficient to determine absolute position because the same indication would be obtained at any point along a given hyperbolic line of position. Therefore, the shore equipment would have to be duplicated with a second set of shore stations, so placed that its hyperbolas would intersect those of the first pair.

Lorac simplified this basic system with the development of a time-sharing arrangement whereby the system functions on two frequency channels and requires only three



transmitters to establish an hyperbolic grid.

At the mobile receiving station on the survey boat, the operator reads the numbers on two dials, red and green; and, from a Lorac grid—a checkerboard of numbered red and green lines—he finds the numbered lines which correspond to the readings on the two dials. The point on the grid where the two lines intersect is the position of the vessel at the time of the observation.

Another instrument aboard the survey boat is a device known as a zero header, which is used in conjunction with the mobile receiver to permit a vessel to be steered in a straight line to a target point. This was especially developed to provide a means for running a straight line between shot points with offshore seismograph exploration boats.

The zero header contains two indicating phase meters which show instantaneous position of the vessel relative to the Lorac grid, and a cathode-ray tube which displays the position of the vessel relative to the target. A pair of knobs set into the dial counters the Lorac coordinates of a target point. A straight line then appears on the face of the cathode-ray tube—one end at the center of the tube representing the target, and the other end the position of the vessel. This trace of light represents the range and direction of the target point; and, as the vessel approaches the target, the line of light decreases in length until only a dot remains when the target is reached.

A movable transparent cursor inscribed with a guide line overlays the face of the cathode-ray tube. This cursor is turned so that the guide line overlays the trace on the tube. If the vessel is steered in a straight line, the guide of the transparent overlay and the trace of light will appear as a single line. If the vessel swings to the right or to the left, the light will swing and will remain out of phase until the vessel is brought back to the proper course.

This device was developed as a means to direct correct steering of a survey vessel while towing a geophone cable. When using the indicating phase meters alone, it was virtually impossible to steer a proper course, and considerable calculation was required on the part of the Lorac operator to compute the position of the vessel as it moved along a line between shot points. When the vessel stopped, it was likely to drift off line with the wind and tide; and the speed of the vessel, together with shifting wind and current, required constant correction of headings to maintain a straight course.

The zero header makes it as simple for a helmsman to steer a correct course as it is for an airplane pilot to follow the indicator of a ship following a radio beacon.

The Lorac UXA type "A" transmitting system consists of three 500-watt stations, the central one of which operates alternately on two frequencies in conjunction with the end stations to generate two pairs of positioning signals. The two end stations operate alternately as position signal-generating transmitters and reference signal transmitters.

Unlike the short-wave limitations of radar, which is good only for horizon distances, the frequencies of Lorac transmitters are such that they follow the curvature of the earth and thus can be received beyond horizon distance. The Lorac system, in fact, has a range of 100 to 150 miles.

The center station of a Lorac network includes the transmitter, antenna coupler, and transmitting antenna. The transmitting units include the power supply, the oscillator-switcher, and the R-F amplifier. The antenna coupler is placed at the base of the 100-ft sectional tower.

Each end station consists of the end transmitter, antenna coupler, transmitting antenna, reference receiver, and loop antenna. The transmitter includes the power supply, modulator, R-F amplifier, oscillator, and a monitor oscilloscope.

Four of Lorac's Gulf Coast transmitting stations are entirely automatic; the others require technicians to operate them. It is a company practice to service the automatic stations once or twice each week to see that they are kept in operating condition.

There is one ambiguity in the Lorac system—that is in the phase measurements which provide the desired position information. The two-phase measurements identify the position of the receiving station relative to two intersecting pairs of hyperbolic lines, but they do not identify the lines. Thus the geographic location of the receiving station must be known at the start of the operation. This means that all vessels must enter a radiation pattern at some known point appropriately marked. The company has equipment for making the necessary lane identification, but it cannot be used under the present frequency allocation.

As to accuracy of Lorac coverage, officials of the company say that a Lorac-equipped boat can return to the same point ±10 ft in the best areas, and to a point ±100 ft in unfavorable locations.

To determine the accuracy of the Lorac system, an overland test was conducted in the vicinity of Tulsa two years ago. Equipment similar to that in commercial use was utilized with transmitters operating in the 1,750-kc to 1,800-kc band presently assigned to radio positioning service. A mobile receiver was installed in a Bell helicopter which permitted observations to be made at any location in the test area, although it included considerable rough terrain.

In the first test, the length of two base lines between the center and end transmitters was measured by flying the mobile receiver around opposite ends of each base line while recording the minimum and maximum readings. For each base line, the difference between minimum and maximum readings was the number of Lorac lanes and fractional lanes between the two transmitting stations. This Lorac distance then was compared with the known distance between the antennas.

In the second test, the helicopter hovered over the first-order triangulation stations while recording two Lorac meter readings. These indicated positions were then compared with known positions.

Using the average of all measurements, the green base-line length was determined to an accuracy of one part in 62,600, and the red base line to an accuracy of one part in 107,791. The probable error in the observations were 2.93 ft for the green base-line readings, and 9.10 ft for the red base-line readings—and officials explained that the latter observation was more erratic because one observation point was directly over the city of Tulsa, and another over the Tulsa municipal airport where local air traffic prevents taking a satisfactory observation.

About 98% of Lorac's operations in the Gulf Coast offshore fields is devoted to seismograph and gravity-meter exploration work, although it has determined locations for about 50 wells. Its clients are principally exploration companies; and its own parent organization, Seismograph Service Corp., although one of the country's leading operators in this field, will take no assignments in the offshore fields. This is a company policy which has been strictly adhered to.

When Lorac engineers are given an assignment to cover a particular area, they first study the X-Y coordinate grid published by the US Coast and Geodetic Survey for that sector and convert the X-Y coordinates into Lorac coordinates.

The Lorac operator aboard the survey vessel is then given the grid prepared for the sector, and thereupon functions in somewhat the same manner as the bombardier aboard a bombing plane. He has no responsibility for the navigation of the vessel other than to give headings to the helmsman, take manual recordings of the shots, and see that the survey vessel maintains a true course along the trace indicated by the zero header.

In a seismograph operation, the recording boat—with the Lorac equipment aboard—operates from 1,600 ft to 2,500 ft ahead of the shot boat, and the Lorac operation must compensate for this distance differential. Since it sometimes takes as much as 200 ft to stop a vessel which is under way, the operator also must compensate for this "way on" as he gives orders to stop for "shooting" at the desired points.

Each "shot" is recorded as to Lorac coordinates so that the vessel can return to any position desired by the survey party chief in charge of the exploration operation. These observations are made manually by the Lorac operator, although the company is now developing an instrument which will automatically record the positions—thus eliminating any human errors which might creep into the operation. With this instrument, one of which is now being used, the meter readings of the green and red meters are printed on a tape similar to an adding-machine tape, so that a printed record is maintained of each "shot" position.

Shot fired by the crew of the "Lanciscot I," one of a fleet of seismographic exploration vessels conducting a search for oil-bearing formations deep under the surface of the Gulf (photo by Fritz Henle for Cities Service).

In positioning wells, i.e., determining the exact location for drilling, Lorac engineers first select a known position closest to the location. This usually is an existing drilling platform at sea with a triangulation station. The survey boat then will proceed to a predetermined position and drop a buoy —making several runs back and forth between the platform and the buoy to further check the position.

Because an area of static, or electrical, disturbance usually surrounds a steel platform, it is necessary to use a stadimeter, an instrument which measures horizontal distance between two objects when the vertical height of the observer and the observed object is known. Hence the Lorac operator, taking readings from the survey boat lying some distance away from the platform, can determine the accurate distance with relation to the desired course from the platform to the proposed well location.

Practically all of Lorac Service Corp.'s operations are confined to marine work in the offshore oil fields, with the exception of one job of aerial positioning in connection with a magnetometer survey to measure the magnetic intensity of the earth for obtaining an indication of geological structure. In this operation, the Lorac equipment is installed in an airplane which flies at low altitude over the surveyed area.

In charge of the petroleum operations of Lorac Service Corp. is C. E. McClure, who is vice president and general manager in charge of the company's office in Houston. A native of western Oklahoma and graduate (electrical engineering) of Oklahoma University, Mr. McClure went to work for Seismograph Service Corp. as a rodman in 1936; worked his way up through the ranks as surveyor, party chief, supervisor; and was sent to Houston when Lorac opened its office there in 1952.

About 90 persons are engaged in the offshore positioning operation. Network chiefs —all college graduates—are in charge of all field work connected with their particular networks, and closely coordinate their activities with those of the various survey party chiefs. Other technical personnel employed by the company are radio technicians, who maintain the intricate radio and electrical connection, draftsmen, operators.

Mr. McClure says it takes from six months to a year properly to train an operator. Most of them are high-school graduates who have studied in radio schools. Many of them are ex-service men who received basic radio and technical training while in the armed services. The role of an operator is not entirely mechanical; because he is far at sea and alone responsible for proper positioning of the survey vessel to which he has been assigned, the operator must be prepared to make spot decisions pertaining to the operation.

For this service, the clients of Lorac Service Corp. pay an average of $6,000 monthly—operating on a schedule of 10 days of work and 4 days of rest. Field reports received from the survey vessels are plotted on maps closely coordinated with survey reports, and these are sent regularly to the client every one or two weeks.

The secrecy involved in geophysical exploration makes it obligatory that Lorac exercise the utmost security in maintaining records, maps, and other essential data pertaining to the operations of their clients. While oil companies "trade" information to a certain extent, the companies which serve them must not; and, since maps pertaining to positioning are closely allied to the data obtained in the making of these surveys, the records of Lorac Service Corp. are carefully locked in their own individual niches.

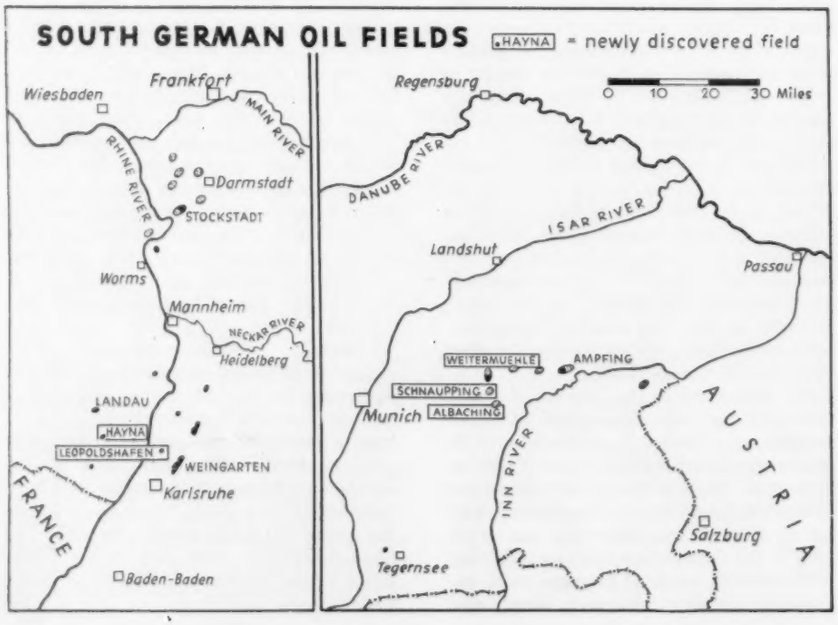
Weather works little hardship on the operation of survey vessels. Only in the roughest seas are they required to suspend work. Of course, conditions such as experienced during last fall's hurricane Audrey can be damaging to Lorac installations. Audrey, the devastating hurricane which raked the Louisiana coast last year, swept out two Lorac transmission stations in the Cameron area and nearly cost the lives of one Lorac technician and members of his family who were forced to take refuge in an abandoned barn when the automobile, in which they were trying to reach higher ground, was completely submerged.

Generally, offshore surveyors have rather "hum-drum" occupations; only occasionally do they encounter emergencies such as that of a few months ago when a huge manta ray attempted to swim away with a gravity meter. Crewmen on the survey vessel thought the meter had been "swallowed by a whale." In a few minutes the manta ray broke water; the cable had been thoroughly entangled in its wings. After killing the ray, the surveyors went back to work. END

German exploration active

With 40 seismic crews in the field and 130 active rotary rigs, West Germany continues to find new oil. Output in 1957 rose to 79,000 b/d.

by A. M. Stahmer



At the end of 1957 West Germany was producing 79,000 b/d, an increase of about 8,000 b/d during the year. Total crude production in 1957 amounted to nearly 28 million barrels, compared with 25 million barrels in 1956.

Fields in the Hanover and the Weser-Ems oil provinces, which were discovered in the early '50's, provided the bulk of this increase, viz., the field group Deutsche (Weser-Ems district) (360,000 bbl), Voigtei field in the same district (320,000 bbl), and Hankensbuettel (Hanover) (280,000 bbl). New discoveries in 1956, especially Leiferde, Eilte-West (both Hanover) and Ortland (Weser-Ems), contributed a total of about 850,000 bbl in 1957, and some new discoveries in 1957 added about 100,000 bbl.

At the beginning of 1957, the Geological Board of the Federal Republic (Amt fuer Bodenforschung) estimated proved reserves at 265 million barrels and probable reserves at 105 million barrels. Proved reserves increased by 15 million barrels in comparison with 1956, while the figure for the probable reserves is 10 million barrels less than a year before.

Producing companies operated 130 rotary rigs and numerous light rigs for shallow holes. Up to the end of November 1957, a total of 2.4 million feet was drilled, compared with 2.3 million feet during all of 1956. About 45% of the total footage was in wildcat and extension wells.

With attempts by producing companies to explore the deep Zechstein and to reach the strata underlying the huge salt formations in northwestern Germany, the average depth of exploratory wells continued to increase. For the first time, two wildcats were drilled past 13,000 ft in Germany. Exploration well Eldingen Z 1 (Hanover) of Gewerkschaft Elwerath was abandoned in August at a depth of 13,258 ft. Wildcat Cismar 3 of Gewerkschaft Brigitta (affiliate of Shell and Esso), which is still drilling, reached a depth of more than 14,800 ft. Results of this well, located near the Baltic

Sea coast in the Schleswig-Holstein province, are still not known.

A current modernization of the drilling and producing equipment in the country was reported. Extensive tests were made by some companies with Russian and French drilling turbines. Thus far it cannot yet be definitely stated that turbine drilling is more economical in formations normally overlying the oil-bearing strata in Germany. In some cases, a real shortening of the drilling time could be achieved; but further experience is needed to determine whether the turbine will gain ground in the industry. Drilling equipment of German design has been applied with satisfactory results. In December 1956, the first hydraulic torque converter rig FG 1-70 built by the Haniel & Lueg GmbH, Duesseldorf, since the war, equipped with a Salzgitter cantilever derrick B 60/30, drilled a record 100,000 meters without major repairs.

Geophysical investigation continued on a high level in the federal republic. About 40 crews are busy with reflection-seismic surveys; 30 more crews are applying hole testing and other geophysical methods. The two German special geophysical companies, viz., Prakla and Seismos, are engaged in numerous countries in the Eastern and Western Hemispheres.

Eight new oil deposits and four natural-gas fields were discovered in 1957, plus some further finds—apparently minor. In the known fields—some of which could be extended by successful stepout wells—development was normal, partly with the help of secondary-recovery methods such as water flooding and gas injection.

In the Holstein province a wildcat, Warnau 2a, of the joint interest Deutsche Erdoel-AG-Gewerkschaft Elwerath was successful in finding a new oil deposit some miles north of the narrow Ploen-Boostedt field. Just as Ploen-Boostedt, the Warnau field is situated at the western edge of the Jurassic trough which extends from Middle-Holstein to the area east of Kiel town and the Baltic Sea. In the second half of 1957, Warnau produced more than 6,000 bbl from the Dogger beta formation—the depth being about 8,200 ft.

Southeast of the old Reitbrook field in the neighborhood of Hamburg, an extension well, Curslack 3, came in on the deep flank of the Reitbrook salt structure as a very small producer. In the Neuengammer gas sand, a formation lying above the oil pay of the Reitbrook field, an underground reservoir for the storage of refinery gas from the Esso refinery at Hamburg was put into operation at a depth of about 1,000 ft; 25 to 35 million cubic meters of refinery gas will be injected here annually to supplement the town gas supply of Hamburg. The gas is to be converted into town gas by a cracking plant which was built by Lurgi, of Frankfort. The storage capacity of the Neuengammer gas sand is estimated at about 150 million cubic meters.

In Hanover province, a discovery was made early in 1957 at Hardesse, between Nienhagen and Gifhorn fields. The exploration well, Hardesse 4, of the consortium Deutsche Erdoel-AG-Mobile Oil AG, struck oil in the Dogger beta formation below 6,000 ft. The extension of the oil deposit at Hardesse, from which about 14,000 bbl crude was produced in 1957, does not appear very large. Other finds in Hanover were made at Blumenhagen and at Wense near the Meerdorf field (northwest of Brunswick) and at the southern edge of the Meckelfeld field (southeast of Hamburg), where in June the exploratory well Meckelfeld-Sued 1 of the joint interest Wintershall-Gewerkschaft Elwerath struck oil in the Dogger beta at a depth of about 6,240 ft. Meckelfeld-Sued is situated on a deep saddle between the salt dome of Meckelfeld and the geological structure of Stelle. While Blumenhagen and Wense wells yield only minor quantities of oil, Meckelfeld-Sued is a noteworthy extension of the old Meckelfeld field.

In the oil province between the rivers Weser and Ems, which link Hanover and the Emsland, further exploration of the Oldenburg concession held by Gewerkschaft Brigitta and Mobil Oil AG made good progress in 1957. Four new oil deposits were discovered here by the consortium, viz., Welpe and Hagen, in the Vechta district; Molbergen-West, north of the Hemmelte field; and, in the last days of the year, Varel, near the Jade belt (North Sea coast). In the Vechta area, wildcat Welpe 1 found the Middle Kummeridge oil-bearing at a depth of about 6,300 ft. Some weeks later, a second well came in one mile east, at a depth of 5,300 ft, with a similar yield. Up to the end of 1957, Welpe produced a total of more than 31,000 bbl, and this is the largest output of all new fields discovered in 1956. In September, wildcat Hagen 1—also situated in the Vechta district—discovered oil, also in the Middle Kimmeridge, at a depth of 6,100 ft. The same pay proved to be productive in the wildcat Molbergen-West 1, which was located 2.5 miles west of the older field Molbergen. In September, a second well came in; and the yield at Molbergen-West increased to about 2,000 bbl monthly.

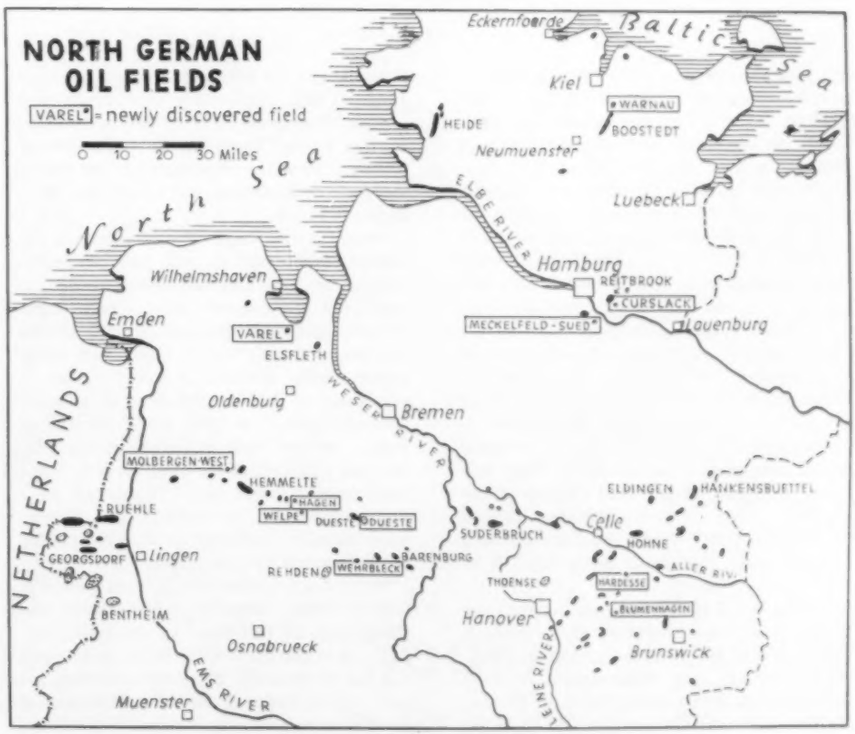
Of special interest is a find at Varel by the exploration well Varel 4, which is situated some miles south of the Jade belt—on the western shore of which the new oil harbor at Welhelmshaven is under construction. Objective of the wildcat Varel 4 was

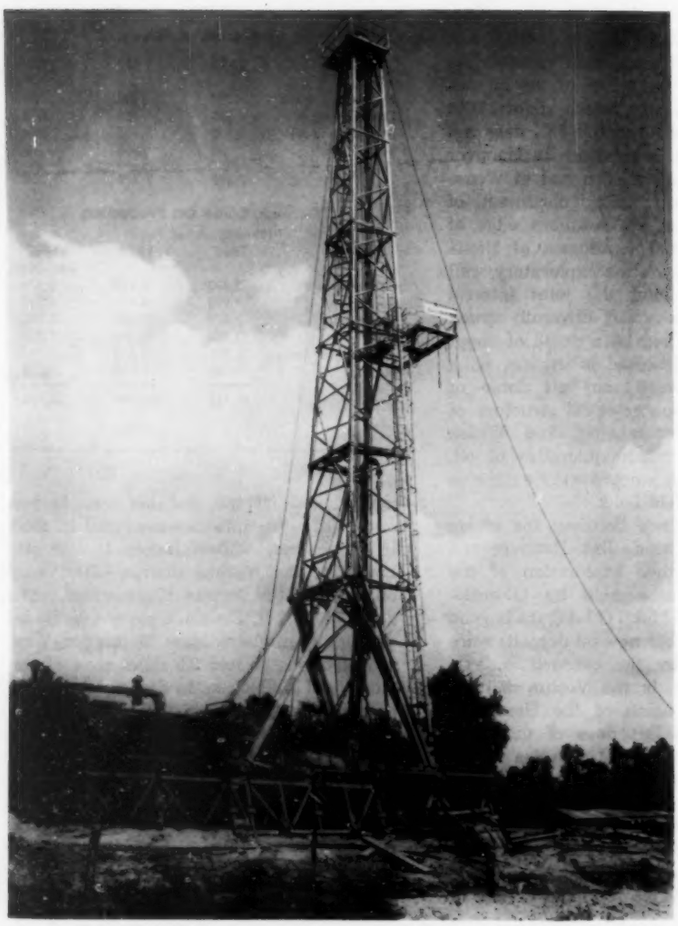
German Drilling Activity
(Thousands of Barrels)

	1955	1956	1957 Jan.-Nov.
Exploratory wells	577	635	553
Extension wells	390	488	519
Production wells	1,365	1,133	1,269
Service wells	76	66	46
	2,408	2,322	2,387

German Crude Oil Production
(Thousands of Feet)

	1955	1956	1957 Jan.-Nov.
Holstein-Hamburg	2,493	2,912	2,875
Hanover	7,928	8,619	8,749
Weser-Ems	3,279	4,245	5,003
Emsland	7,974	8,306	7,869
Upper Rhine valley	591	676	761
Bavaria	80	136	208
Germany total	22,345	24,894	25,465





Cantilever rig with hydraulic torque converter, built by Haniel & Lueg GmbH, has drilled 100,000 meters in Germany.

the Elsfleth sandstone of the Middle Dogger, which had proved to be oil-bearing in the Elsfleth field of Gewerkschaft Elwerath southeast of Varel. With the discovery of Elsfleth, a new Jurassic trough was then explored in northern Oldenburg. In the well Varel 4, the Elsfleth sandstone was encountered below the Hauterive transgression at a depth of 5,071 ft to 5,136 ft. Production tests resulted in a flow of about 20 cubic meters daily through a ⅛-in. choke. The crude has a specific gravity of 0.898. In the eastern part of the Weser-Ems oil province, in December the consortium Gewerkschaft Elwerath-Mobile Oil AG struck a new oil deposit with the wildcat Wehrbleck 1, about half-way between the Barenburg and Dueste-Wietingsmoor fields. Flow test from the Aldorf Serpel lime (Upper White Jurassic) after an acid treatment yielded 0.6 cubic meters of crude per hour through a ⅛-in. choke, the depth being 3,369 ft to 3,382 ft.

At the end of March 1957, an oil find was made by the joint interest Gewerkschaft Elwerath-Deutsche Erdoel-AG-Itag-Wintershall in the upper Rhine valley, 10 miles southwest of Germersheim town at Hayna. Exploratory well Hayna 1 struck light oil (specific gravity 0.826), at a depth of about 4,500 ft, five cubic meters of crude had initially been pumped from two basic sands of the Upper Pechelbronn beds. Structurally, Hayna is a monocline. At the end of the year, daily output of the field amounted to about 70 bbl.

Some weeks later the consortium C. Deilmann-Wintershall AG was successful with a wildcat, Leopoldshafen 1a, on the right bank of the upper Rhine, 5 miles north of Karlsruhe town. The well, Leopoldshafen 1a, came in with a free flow of 10 cubic meters daily through a ⅛-in. choke in sandstone of the Meletta beds at a depth between 4,051 ft to 4,061 ft. At the end of July, a second well at Leopoldshafen discovered a further oil-bearing horizon in the uppermost Cyrene marl (Tertiary) at a depth of 3,067 ft to 3,100 ft. The Cyrene marl initially yielded 12 to 15 cubic meters crude through a ⅛-in. choke.

Natural-gas production of West Germany totaled 12,945 million cubic feet in 1956, and about kept at this level in the past year. Some new gas finds were made in Bavaria and the Weser-Ems province; and this, together with the progressive exploitation of the known natural-gas deposits in the Emsland, will probably cause a further production rise in the years to come. In eastern Bavaria three gas finds were made by Bayerische Mineral-Industrie AG (Mobil Oil) at Albaching, Weitermuehle and Schnaupping—all in the neighborhood of the oil and gas fields Ampfing and Isen. At Albaching and Schnaupping, natural gas is produced from the Lithothamnia lime; at Weitermuehle from the Chatt (Oligocene). While the Isen gas field is already delivering its production through a pipeline to the Munich town works, utilization of the newly discovered gas deposits by the chemical industry is planned.

In Northern Germany a promising gas find was made in the northeastern part of the oil field Aldorf (Weser-Ems district) by Wintershall AG, in June 1957. The exploration well Deuste-Zechstein 1 encountered a gas-bearing horizon in the Zechstein (probably main Dolomite) at a depth of 10,325 ft. Wintershall hopes to obtain a gas production from this well similar to that of the wells in the nearby Rheden gas field, which is now top-ranking in Germany.

In November, the consortium Gewerkschaft Brigitta-Gewerkschaft Deutz-Gewerkschaft Elwerath started regular output from three gas wells which were completed between the years 1950 and 1953 on the geological structure of Grossburgwedel-Isernhagen. This gas pay is the Dogger epsilon (Cornbrash) between 5,750 ft and 6,050 ft. Through a 5-in. pipeline, 40,000 cubic meters of gas is daily delivered to the refinery of Gewerkschaft Deurag-Nerag, at Misburg, near Hanover. The gas is primarily used for heating purposes.

In the next five or six years the German oil industry will be engaged in the second wave of refinery expansion since the war. Nearly all companies have new refinery building plans, viz., Esso, at Cologne; Shell, at Godorf (south of Cologne); BP, in the neighborhood of Dinslaken; Purfina, at Duisburg; and probably Deutsche Erdoel-AG, near Karlsruhe, and Getty Oil, at Rees. Besides the hydrogenation works Gelsenberg, Scholven and Wesseling are increasing their crude intake capacities—to produce more fuel oil.

In the Hamburg area Shell, Esso, and BP are enlarging their plants. Also the refineries which mainly process German crude—such as DEA, Heide, GER, Lingen, and Deurag-Nerag, Misburg—are busy increasing their capacity. Much propaganda was made for the building-up of a fuel-oil refinery at Emden harbor by Gottlieb Duttweiler, the Swiss price-cutter; but it seems still doubtful whether the financing of this project can be settled. Duttweiler apparently hopes to get more financial support from the federal government, and abroad from the American Independent Oil Co. which is to deliver crude from Wafra field (Neutral Zone). It can be anticipated that West Germany will have a crude-intake capacity of about 50 million tons annually in 1965, most of which will be used to produce maximum volumes of fuel oil.

END

Recent petroleum activities in Spain

by J. M. Rios*

SINCE the publication in October 1956 in WORLD PETROLEUM of my general description of oil exploration activities in Spain since 1900, work has accelerated.

As before, three companies are most active: CAMPSA (Spanish Petroleum Distribution Monopoly); CIEPSA (associated with C. Deilmann Bergbau of Bentheim, Germany); and Valdebro (with the cooperation of Adaro and participation of the General American Oil Co. of Texas, DeGolyer and MacNaughton, and other American interests). Other exploration was of little importance. Activity since April 1956 up to the present has been as follows:

CAMPSA: Not much more has been done. So far as geological investigation is concerned, cartographic (topographical and geological) surveys of the Zuazo de Cuartango (Alava) structure were improved during the year 1956, and geological studies were done at Tafalla (Navarra), Ucero, Nafria, and Aldehuela-La Cuenca (Soria) in 1957. Two wildcats were drilled on one structure, that of Leva (Burgos).

Recent Drilling: 27) Leva I (CAMPSA No. 9)—Begun on anticlinal of Leva (Burgos), very near the original Leva drilling (1923), close to Soncillo. This new test started from the Lower Turonian at the vertex of the anticlinal; intersected 250 meters of marly and calcareous Turonian, sandy in the lower portion ($CaCO_3$, 40%); and continued in Cenomanian calciferous sandstone (250 to 404 meters), Albian siliceous sand and sandstone, with beds of black clay, much organic material, lignite and ligneous material (404 to 1,270 meters), a small thickness of Wealden (1,270 to 1,302 meters); and finally entered the saliferous Triassic at 1,302 meters. It terminated after going through 90 meters of salt and carnelian in a Triassic dome, at a depth of 1,512 meters. This well reached some light oil in sand assaying 8%—but with no gas or pressure—at various levels between 497 and 580 meters in Albian formations of littoral facies, consisting of sandstones and black clays with *Orbitolina* and abundant organic material. The anticlinal appeared in depth like a long chimney running through the Triassic, Jurassic, and part of the Lower Cretaceous.

28) Leva II (CAMPSA No. 10)—The gear moved to another side of the same structure—thought at first to be an ordinary anticlinal; whereas drilling just described (Leva I) showed that it covered a salt dome. The gear, accordingly, was shifted away from the vertex to get at the flanks of the dome. Like the previous test, this one also started from the Lower Turonian, and has now reached a depth of 900 meters. The soils intersected are the same, the site being only 800 meters distant from the previous one. The only difference is that it started from a horizon 100 meters higher, stratigraphically speaking, than before. The Lower Cretaceous began to be encountered at 509 meters. This test did not show so far any of the petroliferous signs observed in the previous one.

The very monotonous sequence of hard siliceous fine-grained black clay with a carbonous material and marine intercalations with Orbitolina persisted—nearly flat —to a depth of almost 800 meters. From then on, to nearly 1,300 meters, it changed, surprisingly enough, to a rather steep deposition (medium, 46 deg; maximum 50 deg at a depth of 1,200 meters), changing at the same time to anhydrites and red clays. At about 1,300 meters depth, the sequence came back to the original flat level and, partly, to the original composition of sandstones and black clays. At 1,450 meters, it changed again to red and black clays and anhydrites; present depth: 1,480 meters on the last facies.

Valdebro Activities: Geological and, in particular, geophysical activity has been continued by Valdebro on a large scale over nearly all the possibly petroliferous areas of the peninsula.

Mechanical investigation activities have been continued using the two drills at present available.

25) Puigreig I (Valdebro No. 5)—Located just north of Puigreig (Barcelona): Begun March 2, 1956, and ended August 14 at 3,192 meters. Intersected Oligocene

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(0-670 meters), Eocene (670-3015 meters), and Paleozoic (Carboniferous?) from 3,015 to 3,192, where terminated. Surprisingly enough, there was no Cretaceous, which has considerable thickness a little farther north. Gave no sign of hyrocarbons.

26) Bornos (Cádiz) (Valdebro No. 6)—Performed with recently imported EMSCO G-500 gear, in service for the first time on this test. Operations begun March 19, 1956; and terminated, August 28, at 3,027 meters. Intersected Miocene (0 to 293); Eocene (293 to 580); Triassic (580 to 3,027 meters). The Triassic consisted of saline Keuper. The abnormal thickness, doubtless from tectonic accumulation of the saline materials of the Keuper, exceeded the capacity of the rig and prevented exploration of the lower sections of the Triassic. No hydrocarbons encountered, despite location in area of abundant signs and indications.

29) Matienzo (Santander) (Valdebro No. 7)—Drilling began, September 19, 1956, and ended December 23 of the same year at 1,950 meters. Intersected Wealden (0 to 609); Jurassic (609 to 702); Liassic (702 to 1,166; Rhaetic (1,166 to 1,280); and Triassic (1,280 to 1,950 meters). No signs of hydrocarbons.

30) Almorchón (Cádiz) (Valdebro No. 8)—Drilling begun, September 18, 1956, and ended on September 28, 1957, at 3,405 meters. Entire drilling seems to have proceeded in Eocene formations consisting of red and gray foliated clays which predominate to 1,029 meters, sandstone alternating with clay to 2,214 meters, and red and gray foliated clays again to 3,465 meters.

The first red and gray clays correspond to the Lower Eocene. The age of the other formations traversed is more doubtful, and the tectonic interpretation of the drilling is confused because the deeper levels seem to be Eocene also, but stratigraphically higher.

Some was found at various levels from 754 meters, where sandstones gave the first manifestations. Production tests to determine whether the gas of this well has any industrial value are not yet completed.

31) Asperillo (Huelva) (Valdebro No. 9)—Drilling begun February 17, 1957, and ended June 12 at 3,307 meters. Intersected Pleistocene (0 to 99); Pliocene (99 to 695); Miocene (695 to 1,206); Oligocene? (1,206 to 1,232 meters); hard and crystalline limestones of doubtful age; Cretaceous or Jurassic (1,232 to 2,185); Rhaetic (carnelian) (2,185 to 2,460); and saline and gypsiferous Triassic (2,460 to 3,307 meters). Gave no sign of hydrocarbons, but encountered salty and sulfurous waters.

32) Isla Mayor (Sevilla) (Valdebro No. 10)—Drilling begun on July 5, 1957, and terminated August 22, at a depth of 2,373 meters. Intersected Pleistocene (0 to 128); Pliocene (128 to 686 meters); marls with intercalations of clays, limestones, and sandstones, assigned to the Upper Miocene (686 to 1,047 meters); gray and green argillaceous marls with some gypsum, assigned to the Middle Miocene (1,047 to 1,840 meters); gray and green argillaceous marls, somewhat calcareous, with intercalated limestone beds (1,840 to 2,167); and fine-grained calcareous sandstones (2,167 to 2,197 meters) of the Lower Miocene. At 2,197 meters, very black and ampelitic metamorphic slate began to be encountered, in the Paleozoic, where drilling was abandoned at 2,373 meters.

This test was surprising not only for the lack of Cretaceous and Eocene formations between the Miocene and the Paleozoic, but also for the presence of the latter at so high a level in the valley of the Guadalquivir.

33) Moguer (Huelva) (Valdebro No. 11)—Drilling begun September 6, 1957, and has reached 1,918 meters at this writing. So far, intersected Quaternary and Pleistocene (0 to 152); as yet unidentified Tertiary clays and marls (152 to 714); and limestone with argillaceous intercalations (714 to 1,914 meters) assignable to Cretaceous and Jurassic levels. From 1,914 meters on, levels of massive anhydrite up to 2,047 meters.

From this depth, up to 2,192 meters, massive salt formation; from 2,192 to 2,370 meters, red and green marls and clays of the Keuper; from 2,370 to 2,419 meters, the red sandstones form the Buntersandstein. From 2,419 meters to the final depth of 2,473 meters, black ampelitic shales of the Paleozoic.

37) Ojén Drilling (Valdebro No. 12): Begun December 3, 1957. As of January 16, 1958, at a depth of 1,460 meters. Begun in Eocene clays which continued up to 698 meters with a few banks of sandstone. From this depth up to the current depth, a sequence of more or less hard sandstones with clays intercalated—all in the Eocene.

38) Almonte Drilling (Valdebro No. 13): Begun November 26, ended December 26, after going through: Pleistocene sands and marls from 0 to 6 meters; blue plastic clays (probably Miocene) to 702 meters; Mesozoic limestones, of an age still not determined, up to 835 meters; anhydrites and green and red Keuper marls up to 1,283 meters. From there to the end, black ampelitic shales of Paleozoic age.

CIEPSA activities: In collaboration with Deilmann, intensive geological and geophysical campaigns have been carried on by eight geologists and paleontologists and two seismic crews. Exploratory activities by drilling have comprised the following operations.

15) Apodaca I (Alava) (CIEPSA No. 7): Begun in Turonian and ended at 2,535 meters in marly facies of the Albian, without showing any petroliferous signs whatsoever.

34) Alda I (Navarra) (CIEPSA No. 8): Exploring the same structure as the Zuniga and earlier Gastiain drillings, but located on the northern flank. Begun in Senonian limestone, intersected Coniacian (0 to 500); Turonian (500 to 1,060); Cenomanian (1,060 to 1,950); Albian (1,950 to 3,358 meters) fossiliferous Aptian limestones from 3,450 meters to 3,780 meters. Some marls and hard sandstones are interpolated among the limestones. Drilling has been very difficult, as it was necessary to operate to 600 meters without sludge circulation, and from 3,000 meters on the Albian sandstone has been very hard and abrasive, regular quartzite. Gas was encountered between 2,755 and 2,808 meters, but production tests are being postponed until drilling is finished.

35) Lano I (Burgos) (CIEPSA No. 10)—Begun in June 1956 in calcerous marl of the Upper Cretacean. Traversed the following formations: Senonian (0 to 700); Turonian (700 to 1,063); Cenomanian (1,063 to 1,298); Albian (1,298 to 2,150); Wealden (2,150 to 2,350); Triassic (2,350 to 3,501 meters). Terminated June 1957 at 3,501 meters. Encountered frequent traces of asphalt in limestones above 915 meters, and from that depth on there were some signs of liquid and gaseous hydrocarbons—especially between 1,160 and 1,190 meters—in banks of limestone with low porosity, in the Cenomanian, with cracks showing signs of petroleum. Acidification produced a few hectoliters of crude. This horizon showed no gas or light hydrocarbons.

It is interesting to note that the great thickness of Triassic traversed corresponds almost in its entirety to common salt, with spares intercalations of gypsiferous and dolomitic marls. This is interpreted as a deep salt dome.

36) Trevino I (Burgos) (CIEPSA No. 10)—Begun in an Oligocene anticline. Started in February 1957 and terminated at a depth of 2,595 meters. Intersected continental Teritary (0 to 1,545) and Triassic (1,545 to 2,595 meters). Here there follows a salt dome hidden in depth, where 1,000 meters of salt were encountered with some intercalation of compact red clay.

39) Trevino II Drilling (CIEPSA No. 11): About 3 kilometers to the west of Trevino I, begun October 25, 1957; has reached a present depth of 1,900 meters, and continues. It has gone through Oligocene, Campanian, and Scurtorian; and, after traversing a fault, Cenomanian. After 80 meters of this formation and a new fault, it encountered the Coniacian, and a normal sequence. At present it is traversing the Turonian.

40) Lano II Drilling (CIEPSA No. 12): Situated about 500 meters from the village of Baroja, a distance of 5 kilometers to the northwest of Laño I drilling. Drilling operations were to begin January 25, 1958.

Other activities: Several tests of less than 1,000 meters have been made in some of the chimneys of the Cantabrian region by the Compania Petrolifera Iberica, with no positive results.

A well to which the domestic press paid much attention was that drilled at Banatae (Jaen) by an organization whose purposes had nothing to do with oil prospecting. Before drilling was started, the presence of a pocket of oil at 520 meters had been announced. Results were negative END

NEW TOOLS FOR THE GEOPHYSICIST

Development of new techniques and new equipment for geophysical reconnaissance has reduced the risk of exploratory drilling by two-thirds at a cost of only 10% of the total bill for land and drilling.

Difficulties of finding new oil in often reworked areas in the United States and in studying remote areas elsewhere in the world have stimulated continued improvements during the past year in equipment and techniques employed by geophysicists. The geophysical phase of the industry is expanding in line with the need for new and better equipment. In the United States alone, the petroleum industry spends $200 million per year on geophysics, but this is only 10% of the total outlay on exploration: Outside the United States, current geophysical costs are even greater because of the higher expense of keeping crews in the field.

In his address at the last annual meeting of the Society of Exploration Geophysicists, President Roy F. Bennett suggested that the amount spent on geophysical reconnaissance is too low because of its proven effect in reducing oil-finding costs. The 10 cents out of the exploration dollar now spent for geophysics reduces the risk of exploratory drilling by two-thirds, he said. Wildcats based on geophysics are 16% successful, on geology alone 9.3% successful, and without technical advice only 5.5% successful.

For reconnaissance in remote areas, the manufacturers of equipment have developed highly portable equipment which is capable of results equal to heavier and more bulky units. Transistors are being incorporated into many instruments. A transistorized magnetometer has been built which weighs only 15 lb. The earlier model weighed 250 lb. A transistorized power converter recently introduced weighs less than 2 lb, and measures only 4 in. by 3 in. It replaces a dynamotor weighing five times as much and occupying twice the space.

Seismic units are being broken up into highly portable units. Small in size and light in weight, these may be carried by helicopter or bearers over difficult terrain. Miniaturization of equipment is of particular advantage in work outside the USA.

Manufacturers supplying equipment for the industry still are devoting much research to the development of office playback systems for better interpretation and presentation of seismic records. Equipment has been designed to rework old seismic records. Conventional seismograms may now be taken out of the files, updated, and stored on magnetic tape for replay and study.

In the development period of magnetic recording, a number of differing systems were developed—each requiring its own particular office system for playback. Equipment now has been developed which makes it possible to transcribe magnetic records from discs to tapes, or from one type of tape to another. This will permit greater flexibility in contracting without requiring modification of field recording equipment to produce records demanded by central-office systems.

The industry is experimenting with additional methods of imparting energy to the earth without use of explosives. In their report to the SEG on research and progress in exploration, Henry F. Dunlap and Curtis H. Johnson stated that at least two laboratories are experimenting with frequency-modulated continuously-excited seismic waves. An electrical or mechanical vibrator is used to excite the ground seismically at a slowly varying frequency. This wave suffers reflections and refractions which arrive at remote seismometers delayed in phase. The output of a seismometer at the source is correlated with the output of remote units. One form of continuous-wave generator consists of a pair of motor-driven flywheels with eccentrically-mounted weights. Interference from surface waves has given trouble.

The same authors also described another approach to offshore survey work, involving the use of electrical profiling. This is done by feeding an electric current through electrodes. It is necessary to trail a 1,000-ft cable from the survey boat.

Elsewhere in this issue is a report on still another offshore technique based on US Navy sonar developments during World War II, which are now released. In this technique, highly repetitive sound sources replace explosives. For offshore work, surveys can be made from a survey boat moving as rapidly as 600 ft per min. Deep penetration is claimed with echo-sounding techniques. A modification for onshore work involves a compact sound source which can be lowered into a shallow bore hole.

Under water, a powerful spark is used; while onshore a new low-frequency sound source operating below 100 cycles is employed. Developer of the technique believes that the continuous flow of information will be much better than that made available through the use of explosives. Frequency can be selected in accordance with the terrain, and the energy directed to the desired spot.

For surveys in difficult areas, a new system of magnetic-tape recording has been developed which is known as the seismic integrator. The system, as described elsewhere in this issue, eliminates extraneous energy from seismic records. Shots are made at varying depths to aid in achieving this result.

Another technique involves the use of pressure geophones, similar to those used in marine and marsh work, lowered to varying depths on bore holes.

Chemical analysis is being used in regional exploration research. Chemical logging is being done with the aid of the mass spectrometer and the infrared absorption analyzer. Gas chromatography has been borrowed from the oil refinery to study hydrocarbon constituents from mud returns.

At a meeting of the nuclear symposium of the American Chemical Society at Miami last summer, Richard L. Caldwell and Robert F. Sippel of Magnolia Petroleum Co. reported on the use of neutron and gamma-ray sources for chemical analyses in the bore hole. By observing the prompt gamma rays emitted during neutron bombardment, it is possible to identify carbon, oxygen, hydrogen, sulfur, magnesium, and silicon in a bore hole.

On the basis of delayed gamma rays, it is possible to identify oxygen, aluminum, and silicon. Density of formation rock surrounding the bore hole can be ascertained as an aid in the interpretation of gravimetric and siesmic surveys.

It is through the continuing research and development by oil and seismic companies that the industry is able to continue finding ample supplies of oil to meet the constantly rising world demand. In the United States, for example, there must be an increase of 60%, in exploratory drilling by 1965, when the domestic industry must find 9.5 billion barrels of new oil to maintain reserves and replace quantities used. To make discoveries of such magnitude possible, the vast pool of technical skill in the industry must continue to develop new tools for the geophysicist. END

The seismic magnetic integrator

A new method of magnetic recording has been developed to eliminate extraneous energy from seismic records. Useful records are being obtained through magnetic integration in difficult areas where seismic exploration has been largely unsuccessful.

by Edward G. Schempf and K. A. Robertson

MAGNETIC tape recording has become almost as common in seismic exploration as in other commercial fields. Until recently, magnetic tapes have been used almost exclusively for the purpose of data presentation in the geophysical industry. Using a new system of magnetic-tape recording, it has been found that usable seismograms are now derived from seismic exploration in areas where heretofore very little or no usable data could be obtained from conventional seismic methods.

The never-ending search for oil reserves has led the geologist and geophysicist to areas where until recently seismic exploration had very little or no success. Some of these areas may be enumerated as follows: The Delaware basin; West Texas; New Mexico; The Four Corners area of New Mexico, Colorado, Utah, and Arizona; the central Mississippi state area; and the complex areas of Louisiana.

Extraneous energy, normally caused by horizontally traveling seismic waves, has always bothered the geophysicist, and at times rendered seismograms useless. The use of filters has done a great deal to improve the quality of the records, but only where the noise frequency is not the same as the frequency of the reflections being recorded. Excessive use of filtering can destroy the true character of the reflections being recorded, and may also introduce on the record energy which is caused entirely by the instruments (see Fig. 7).

In the past few years, a great deal has been accomplished in the cancelling of interfering noise by the use of multiple geophones laid out in predetermined patterns along the line of profile. This is possible because the noise in general will arrive at the geophones from an oblique or horizontal path, whereas the reflected energy is arriving from a nearly vertical path (see Fig. 5). The geophones can be arranged in a pattern which will cancel a portion of the noise and not affect the reflected energy. The use of pattern holes has been successful in many instances—although a set-hole depth has governed its flexibility (set-hole depth necessary for record correction data); and extremely high shot-hole drilling costs and permit costs have discouraged many operators.

The purpose of magnetic recording has to date been mainly for the presentation of data (e.g., record sections) and the preservation of data. The recording method herein described adds a third and extremely important purpose to magnetic-tape recording, viz., that of improving seismic data. The advent of magnetic-recording systems gave us the ability to store multiple shots in their original state, and we are also able to use these data later—over and over again if necessary.

By using a magnetic recorder in conjunction with a standard set of seismic instruments, the integration of energy from successive shots in a hole can easily be accomplished.

Fig. 1 shows theoretically how the Magnetic Integrator works.

This diagram shows the surface positions of geophones located on either side of a shot hole in a normal split-spread position

Edward G. Schempf, president of Precision Exploration Co., Tulsa, Okla., entered the geophysical industry in 1935 with Western Geophysical Co. He joined United Geophysical Co. in 1937. During the 15 years with United, he spent time in South America as a party chief. Later he managed both foreign and domestic operations. Mr. Schempf resigned from United Geophysical Co. as executive vice president to become president of Precision in 1952. He was graduated by the University of Wisconsin in 1931.

K. A. Robertson, vice president of Precision Exploration Co., Tulsa, since 1951, first went to work for United Geophysical Co. in California after having obtained his geological engineering degree in 1937 from Colorado School of Mines. He served as supervisor in the Mid Continent and Rocky Mountain areas for five years, and was manager of United's Canadian operations from 1948 until 1951.

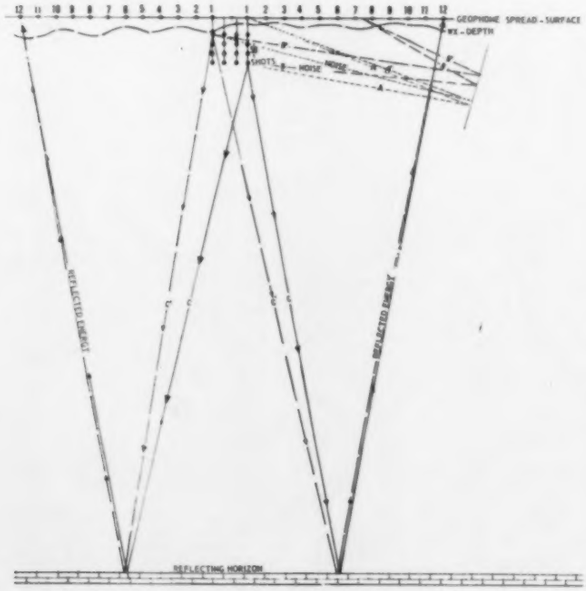
View of recording truck, complete with seismic amplifiers and magnetic-tape recording equipment.

(24 positions). The vertical lines in the center represent the position of the shot holes, showing the location of the charges loaded some distance apart. The shots are detonated separately—progressing from the deepest shot to the shallowest. The horizontal line at the bottom of the diagram represents a reflecting horizon. There may be more than one reflecting horizon. The lines extending downward from the center lines represent a portion of the energy which, as shown by the concentric circles, progresses away from the source, or shot. This energy is then reflected back to the surface, as in a normal seismogram. The diagram shows two such shots, the deepest and the shallowest.

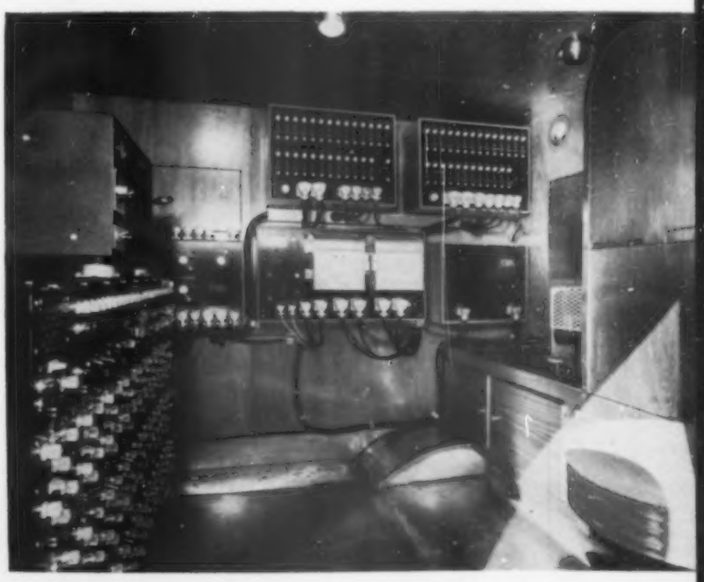
The lines extending upward and sideways represent the travel path of noise. The irregular lines near the surface are meant to represent the travel path of noise known as ground roll. The lines extending out almost horizontally and then reflected back to the surface geophones represent the type of interference generated by small near-surface fractures, buried topography, solution caverns, and possibly concretions.

Seismic energy, and also noise, are generated in the shot hole by the dynamite explosion. The seismometers are placed on the surface between points *A* and *B*. They pick up the reflected energy which bounces off the reflecting horizon at the bottom of the figure. They also pick up the noise generated by the shot, or from other sources, at an oblique angle to the line of profile or geophones. It is apparent that, if the point source of the energy (the dynamite explosion) is moved in a vertical plane in the shot hole, the travel path of the reflected energy will change only slightly—but the travel path of the noise would change appreciably. Then, by combining a number of these shots at different levels in the shot hole, and by correcting for the

Fig. 1 Diagram indicating method employed in shooting, and lines of reflection in the seismic magnetic integrator system.



Interior of recording truck: At left are standard seismic amplifiers and camera. At rear are double-drum FM tape recorder and seismic magnetic integration equipment.



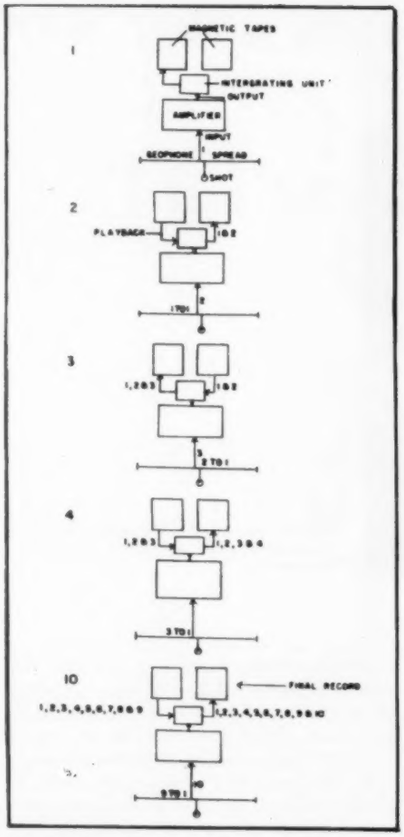


Fig. 2 Schematic diagram of instrument set-up employed, showing the progression of successive shots.

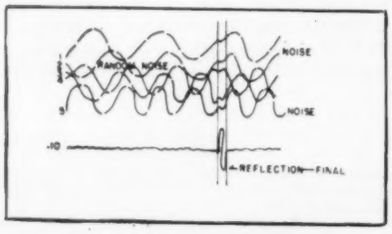
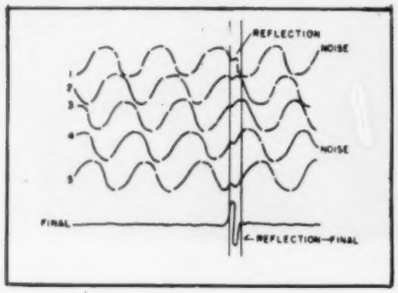


Fig. 3 This diagram depicts random energy imposed on a magnetic tape at one point common to all traces. In time, a small amount of reflected energy is introduced. The lower line is representing an integration of 10 such traces, with the result and cancellation of the random noise and the buildup of the weaker reflected energy.

Fig. 4 This diagram is very similar to Fig 3, except that the noise represented here is of a single frequency but appears on the trace at different times. Again, a small amount of energy or signal is introduced at the same time on each trace. The ratio of noise to signal is 10 to 1. The lower line, or final, represents the integration of the upper lines showing the cancellation of the noise and the increase in amplitude on the signal.



difference in arrival time for the reflected energy from the different shot depths, the reflected energy is being added together—since it arrives at the same time while the noise is being cancelled because, by changing shot depths, the travel time of the noise is changed more than the reflected energy, and any correction to the latter does not appreciably affect the former—thus leaving the noise out of phase and eventually cancelling itself (see Fig. 6).

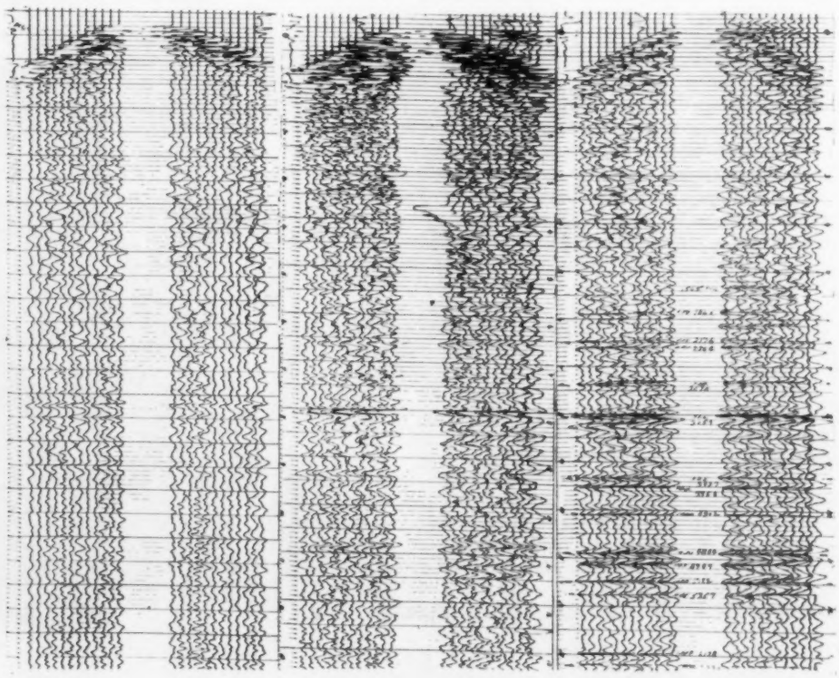
The instrument set-up necessary for integration of shots is shown schematically in Fig. 2. Part 1 of the diagram is labeled so the various units may be identified. The small horizontal line in the lower part of this drawing corresponds to the deepest shot in Fig. 1. The rectangle labeled "Magnetic Tape" represents the split sides of a magnetic tape in a magnetic recorder devised for the purpose of recording seismic impulses. This would include all necessary timing devices, modulators, and demodulators. Parts 1—2—3—4, etc., show the progression of successive shots recorded on the tape and then played back and integrated with each succeeding shot. Part 2 shows a 1-to-1 ratio between playback and shot energy. Part 3, a 2-to-1 ratio, etc., up to Part 10, which shows a 9-to-1 ratio. This is done so that each shot has an equal value on the tape and thus, through integration, will be equally cancelled or built up. Fig. 2 depicts a double-drum magnetic unit and, directly below the tape transport, a regular seismic amplifier. Each transport will have 24 recording heads; and, of course, in the truck there will be 24 recording amplifiers—one for each head. On the first shot at the bottom of the hole, the reflected energy goes from the geophones into the input of the 24 amplifiers, and from there to transport No. 1. On the second shot, which is detonated shallower in the hole than the first, the energy again goes into the input of the amplifiers and onto the tape transport No. 2. However, as this energy is going on the tape, it is combined with the energy from the first shot at the output of the amplifier, and the combined energy from tape No. 1 and from shot No. 2 are recorded on tape No. 2. This procedure can be repeated over and over for as many shots as is desired.

The end result is a tape with the reflected energy added together and the noise cancelled—leaving reflections which are easily picked and interpreted. The remaining tapes can be erased and re-used, or they can be saved as monitors.

In order to be sure that the reflections on any two tapes coincide exactly, it is necessary to know the time difference between the two shots. This is done by lowering a velocity cable into the hole and taking a regular up-hole velocity record. From this record we can readily compute the differences in time between any two depths in the hole. Knowing the difference in time between shots, it is then a simple matter to rotate one drum in one direction or the other in order to correct for the differences in arrival times for the reflected energy and, consequently, to make the arrivals match up exactly.

It is readily apparent that all of the tapes could be taken individually, and integrated later rather than in the field. It is also apparent that individual holes in a multi-hole pattern could be shot individually and all of the original tapes saved and then integrated later either in a vertical manner one hole to the other, or all those shot in the same horizontal plane integrated and the resultant tape from this process integrated with the resultant tape from the next higher

Fig. 5 This is an example of 10 small charges added together to get the necessary information in an area of considerable culture. The three records represent the first, sixth, and tenth of a series of ten 1-lb shots added sequentially.



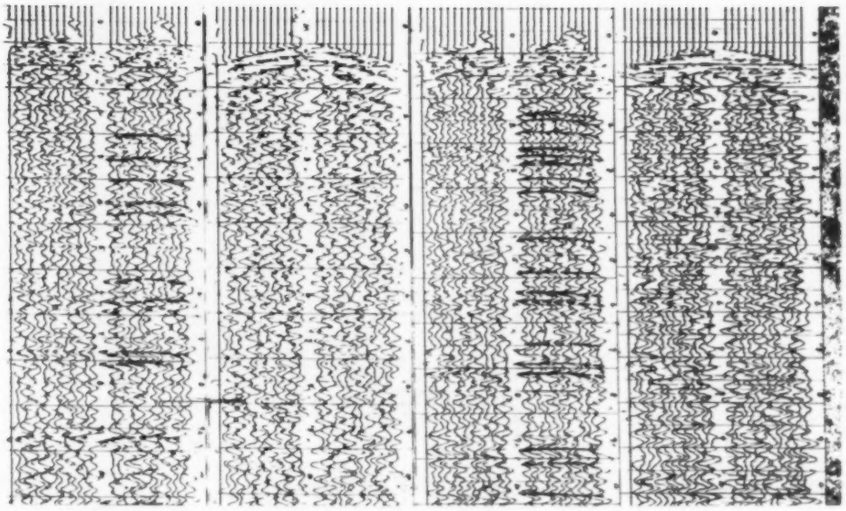


Fig. 5 These records were shot in the Four Corners area of Utah. The wind-swept Navajo sandstone was exposed on the surface, and elevation changes were of such magnitude that the use of multiple geophones was inadvisable. The record at the right is a standard recording, using 80 lb of dynamite at 285 ft, F-1-25-53 filter. The second record from right is 4-shot sequential record, 20 lb, 60 ft apart starting at 280 ft. The third record is another 80-lb shot, using an F-1-25-53 filter. The fourth shot is a 4-shot sequential, 20 lb each, 60 ft apart. Each 4-shot sequentially integrated record was obtained in the same shot hole as the 80-lb standard recording immediately above.

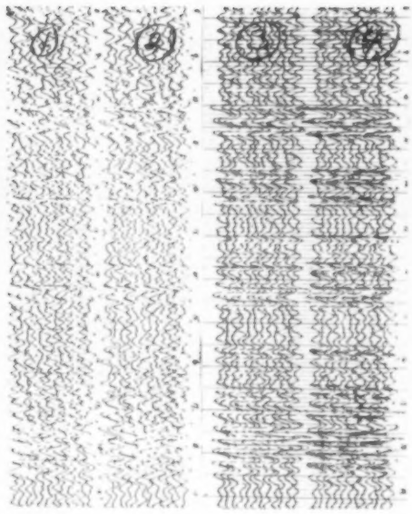


Fig. 6 The four records represent a series of 2-lb shots sequentially integrated. Record No. 1, the first 2-lb shot, shows effect of shot-generated noise and 60-cycle high-line pickup. The fourth integrated shot shows that almost all of both types of noises have been cancelled. The deeper and weaker reflections now stand out quite clearly.

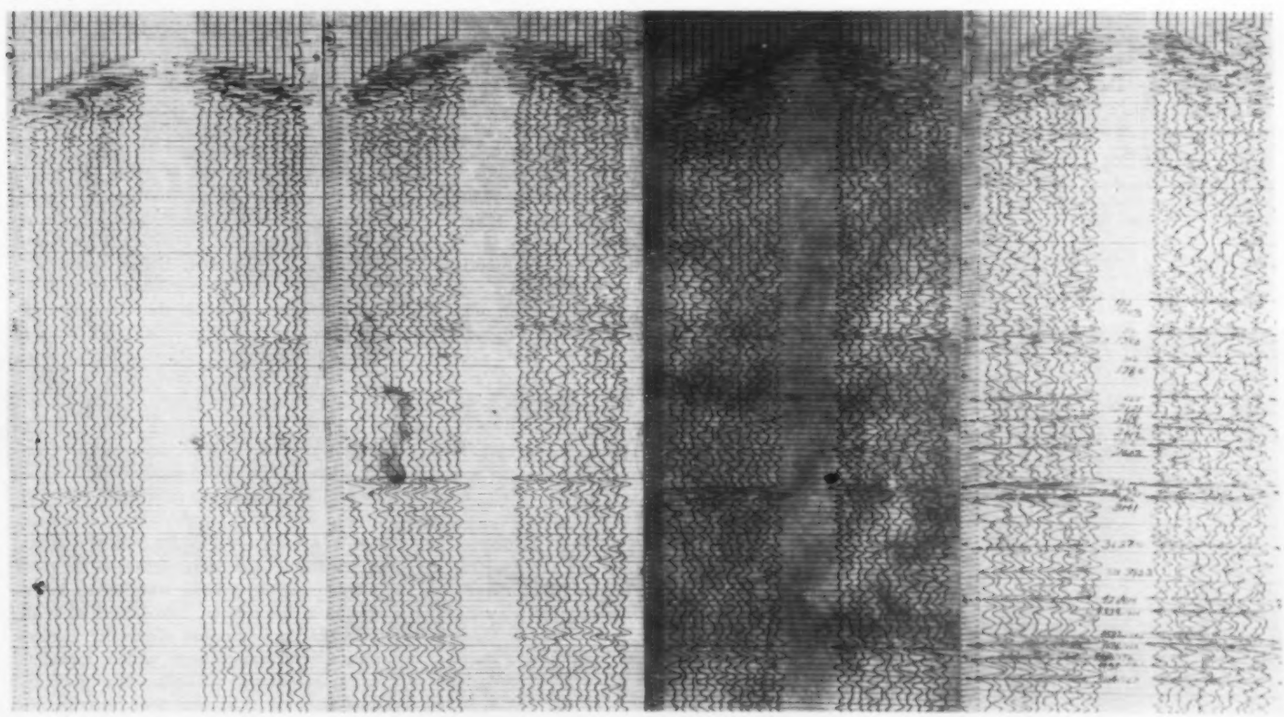
plane until all the shots have been integrated in both horizontal and vertical manner. This method of adding reflected energy and cancelling noise is called selective compositing.

The advantage of this new integrating technique, employing magnetic tape as the medium of integration, is fundamental; i.e., it yields a much better signal-to-noise ratio, and thereby yields usable seismograph records in areas previously thought to be impossible by most geophysicists.

A second advantage is one that, in many instances, could be invaluable. By adding reflected energy using a series of extremely small dynamite explosions, seismograph records can be recorded in areas where dwellings, pipelines, or other operational obstructions have made seismic exploration previously impossible (see Fig. 8).

The inventor of this new method of magnetic recording and integration is Edward G. Schempf, president of Precision Exploration Co. This method has been patented under USA Patent No. 2806,545—with patent right assigned to Precision Exploration Co., Tulsa, Okla. END

Fig 7 The four records represent four 2½-lb shots added sequentially. Reading from right, the first three are completely unfiltered, and the fourth played back through a F-1-25-0 filter. Although some residual noise is present on the record, the reflections stand out clearly. With this wide-band filter, there can be no instrumental effects such as ringing.



NEW TOOLS FOR THE GEOPHYSICIST

Subsurex—

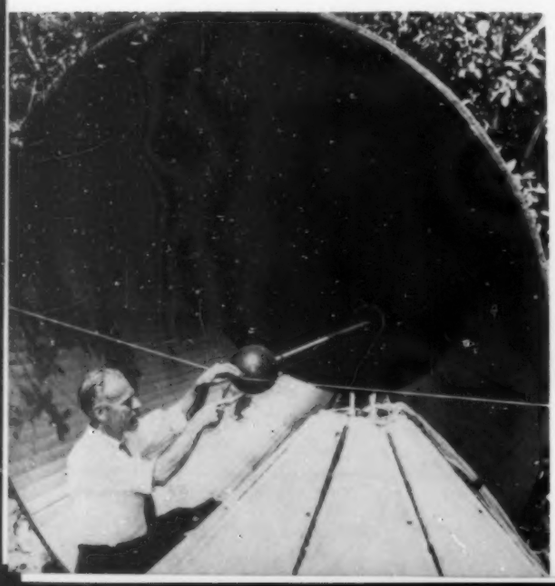
a new approach to geophysical exploration using sonic frequencies

by Louis R. Padberg, Jr.

Experimental equipment has been developed employing electronics to produce more readable subsurface records with higher resolution. Highly repetitive sound sources are used to replace explosives. Deep penetration is obtained from a survey boat moving at 600 ft per min. Recent experimental work involves use of an under-water electric spark for offshore surveys, and a new compact sound source for use in shallow bore holes to replace conventional explosives.

LOUIS R. PADBERG, Jr., electronic scientist with the U.S. Navy Electronics Laboratory, San Diego, Calif., is a registered professional engineer in the state of California. He has an accumulation of 25 years' experience in the field of electronics—14 years of which have been in the field of under-water acoustics. He is head of the short-pulse and classification section of the acoustics division of the naval laboratory.

Fig. 12 The author experimenting with under-water spark sound source (photo courtesy San Diego Evening Tribune).



SUBSUREX[1]—stands for subsurface explorer, and is a new method of exploring the substrata of the earth. It is particularly applicable to offshore oil exploration, but is not confined to water areas. The technique represents a radical departure from present seismic methods, which have not changed basically for more than 30 years. It is not an overnight development, but the result of many years of painstaking work. While it follows echo-sounding techniques in many details, still there are many differences. The author is employed by the military, and certain material herein was covered for several years by secrecy restrictions. All such restrictions have now been removed.

The techniques about to be described have not been successful prior to this because certain physical barriers prevented their application. The method is based upon the application of a few basic, and critical, parameters—each of which is necessary or deep penetration of the earth materials is not possible. These are: (1) extremely high power, comparable with explosives; (2) pulses of very short duration; (3) frequencies within the aural spectrum; (4) projection of the energy in a narrow beam.

[1]Both the method and apparatus described in this article are covered by patent applications pending in the USA Patent Office.

By using the abovementioned parameters correctly, it is possible to portray directly the contour of the ocean floor and the strata underlying it. Present techniques require many hours of work to reduce wiggly-line traces into the same form for analysis. There is one basic difference from conventional seismic methods; i.e., this represents a continuous flow of information, while explosive methods are based upon a one-shot device. It is this feature which allows true profiles to be obtained. Other major differences are: (a) Transmission is at a seselected frequency rather than being broadband. Explosives have the energy distributed over a wide range of frequencies, and only the very low portion of the spectrum is utilized and the unwanted frequencies filtered out. (b) Explosives radiate their energy in all directions, while Subsurex directs the energy only to the spot from which information is desired.

In the Subsurex method, high-intensity sound is directed vertically into the earth. The returning echo information is received at the same spot—greatly simplifying interpretation of the echoes. The degree of depth penetration is a function of several factors. Evidence will be shown which indicates that, for some type of sediments, penetration of several thousand feet can be obtained even at frequencies as high as 10,000

Fig. 1 High-power short-pulse projector.

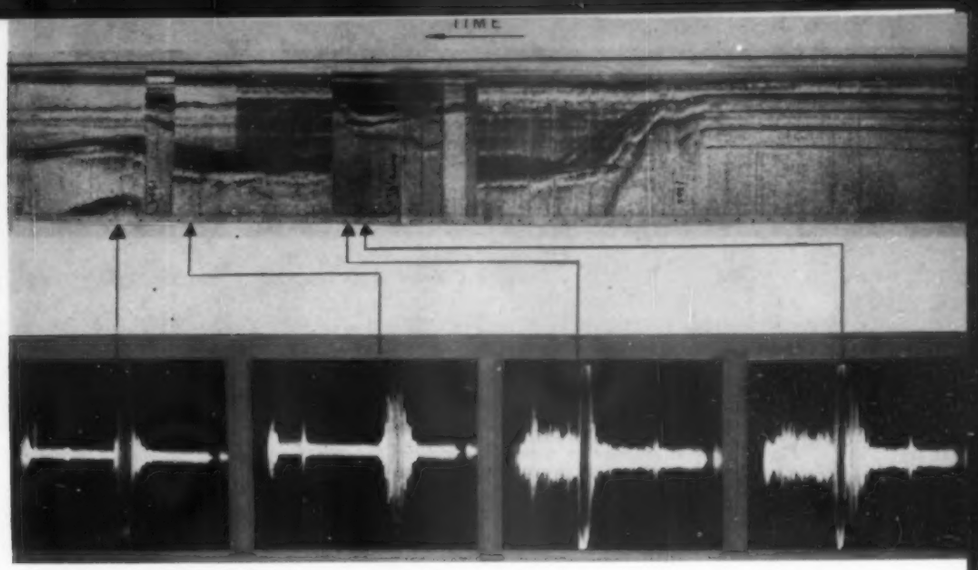


Fig. 2 Ocean floor off Southern California.

cycles per second. Generally, for coarse-grain sediments, deep penetration will require the use of much lower frequencies. Earth structures are very complex, so that no hard-and-fast rule can be given. The choice of frequency will depend upon the type of information desired. Evidence has been obtained which indicates that the type of material can often be determined without the necessity of coring. This is based upon a study of the echo structure. Samples of this are shown in Fig. 10. It is the opinion of the author that, given time and proper facilities, Subsurex will eventually do everything present seismic techniques now accomplish. This will mean much quicker surveys at a greatly reduced cost. One boat will be able to accomplish that which now requires a small fleet of assisting boats.

Up to about the year 1944, SONAR (stands for "sound navigation and ranging") used frequencies generally above 20,000 cycles and input powers to sound projectors up to about 600 watts. Attempts to use greater powers proved futile for several reasons. Projectors of this era would break down either mechanically or electrically, or both, when subjected to powers above this level. In addition, at about this level, a phenomenon known as "cavitation" set in. Basically, this is caused by small bubbles being generated at the projector face which cause a break in coupling. This and other technical difficulties caused SONAR to make very little advance. The author, and a small group, tackled the problem, and eventually found a way to circumvent the barrier.

Studies showed that cavitation was directly related to the duration of the pulse. By making the pulses very much shorter than those being conventionally used, the bubbles did not have time to form. The face area also played an important part. A definite amount of power can be applied to any one small area. Higher power required larger face areas. Another factor which entered into the picture was the beam width of the sound. For a good narrow beam, the projector has to be about six wavelengths wide. This is one of the reasons high frequencies have been used for so long. As we go to very low frequencies, projector dimensions get very large if we require a very narrow sound beam. It does not make sense to waste power on illuminating areas larger than we wish to study.

Attempts at exploring the use of very high power at low frequencies were hampered by the fact that there were no projectors manufactured which were suitable for such studies. The author designed such a unit. It is shown in Fig. 1. This unit is based upon the principle of "magnetostriction." It has over 50,000 very thin, almost 100% pure nickel laminations. Although this unit is now many years old—even at this writing—the measured pressure level in the water has never been exceeded by any known sound projector in the world. The records shown in this article were made using this unit. A patent is pending. Before looking at these sea records, let us digress a moment and consider several items which are related to the exploration of oil.

As has been true in the past, to date there is no known successful method of locating petroleum directly. Such may not always be true; but, for the present, all methods—including Subsurex—merely locate structural features such as anticlines, faults, etc., where oil is likely to be accumulated. The most promising of the direct methods lies in the analysis of local soils to determine where there are large concentrations of hydrocarbons.

Because of the low conductivity of petroleum, numerous attempts have been made to measure the resistivity of the earth materials and to correlate this with different strata. All such information is helpful, but usually insufficient in itself. Occasional attempts have been made to locate it by using radio frequencies. This usually ends in failure, mainly because of one parameter over which we have little control, viz., transmission loss. While there is a great dearth of material on the transmission loss through all types of sediments, one thing has been established with certainty, viz., *attenuation loss increases as frequency increases.* Therefore, very low frequencies are used in seismic exploration.

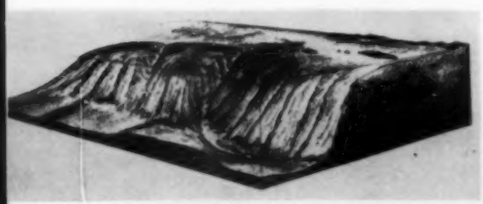
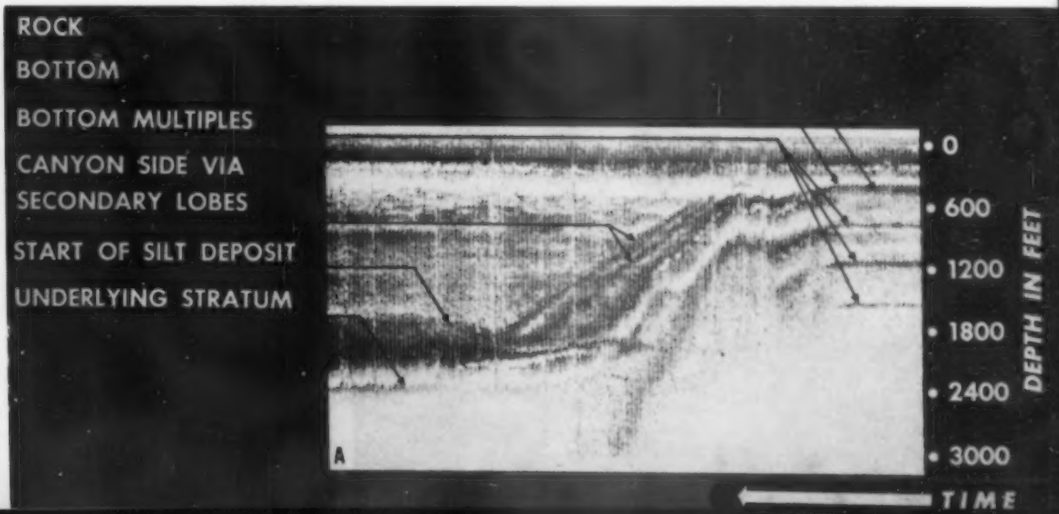


Fig. 3 Comparison of Subsurex record with actual development: (A) Subsurex record; (B) hypothetical development of Coronado Canyon (Emery et al., Plate 2, Journal of Geology, *Vol. 60).*



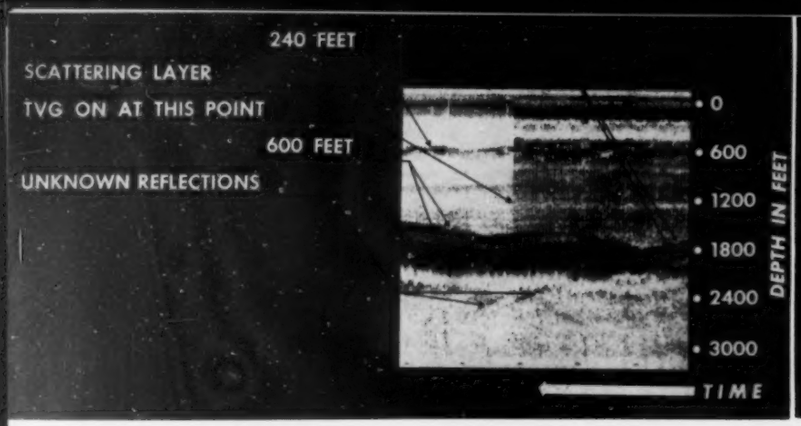


Fig. 4 Topmost sediment on ocean floor: material fine-grained, and has high organic content; measures over 600 ft. thick.

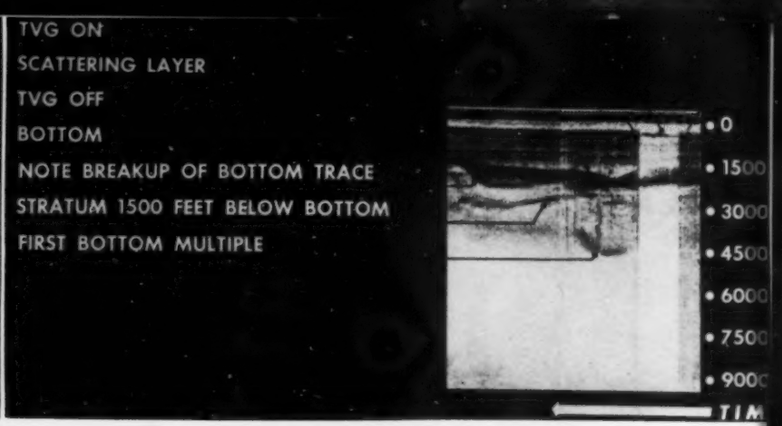


Fig. 5 Rock strata showing 1,500 ft below ocean floor: Note difference of slope from bottom.

The reason for staying in the frequency region between about 20 cycles and 100 cycles is not completely understood. One of the reasons, of course, is following precedent. Another probable answer is that instruments used in receiving had resonance in this region. There should be no cutoff in usable frequency until it has been proved that attenuation losses are other than gradual. If we are to have increased resolution, higher frequencies will have to be used. One thing is certain: We must have sufficient source level to overcome the transmission loss.

Present seismic techniques do not give sufficient resolution to detect earth structures such as reefs, pinchouts, and many types of stratigraphic traps. There is a basic reason for this: The wavelength is too long. Frequencies between about 20 cycles and 100 cycles are suitable for detecting very thick sediments, but the smaller ones cannot be delineated because the wavelength is just too long. Using Subsurex techniques, the correct frequency is chosen for the particular job at hand. With sufficient power to overcome the transmission loss, the use of higher frequencies will permit very high resolution, and strata not now seen will show up. It appears that in time it will be possible to delineate directly an actual area of mineralization. This cannot be done if we continue to work only at very low frequencies.

Subsurex experimental equipment consists of: (1) very high-power transmitter which generates very short pulses of a desired shape; (2) a high-power sound projector; (3) high gain receivers; (4) a special means for making short pulses audible; (5) a recorder of special design using a chemical paper with a wide dynamic range; (6) a cathode-ray oscilloscope with special features for echo expansion; and (7) a magnetic tape recorder.

At this date, there is no manufactured equipment equivalent to Subsurex. The entire equipment can be carried on a fairly small boat.

Subsurex Records: Let us first take a look at a typical traverse of the ocean floor off the California coast. Fig. 2 shows a portion of the continental shelf, a continental escarpment, and a delta formed at the foot of the escarpment. The record was made while the survey boat was moving at a speed of six knots, or a coverage of approximately 600 ft per min. This is a reduced photo of the actual unretouched record.

Let us examine the record in sections. Fig. 3 shows a hypothetical development of this spot along with the actual record. The agreement between theory and practice is remarkable. The author had not seen the theoretical development, nor spoken to the author prior to the run. The thick sediment lying at the foot of the escarpment has never been seen prior to this. A high-grade depth sounder was running simultaneously with Subsurex, but did not show any sediment; in fact, the bottom was so soft that the echo-sounder trace dissappeared about halfway down the escarpment. Fig. 4 shows a portion of this sediment. That the sound is going through the entire sediment is apparent. Since the velocity through the sediment is unknown, a velocity of sound through water is used which indicates the sediment is at least 600 ft thick.

If we examine Fig. 5, we shall see that a rock structure appears below the bottom midway between the bottom and the multiple of the bottom. Note that the slope is just opposite the bottom. The record indicates that this rock structure is at least 1,500 ft below the bottom. Note, at the end of Fig. 2, that the bottom sediment gradually thins out. Now refer to Fig. 6. Here we see several horizontal strata underlying the steep slopes of a canyon wall. Note the deep sediments on the canyon sides.

In Fig. 7 we have a good record of a section of the ocean floor where there appears to be considerable faulting. The bottom multiples are useful for studying such structures, as they bring out more detail than is shown on the bottom trace.

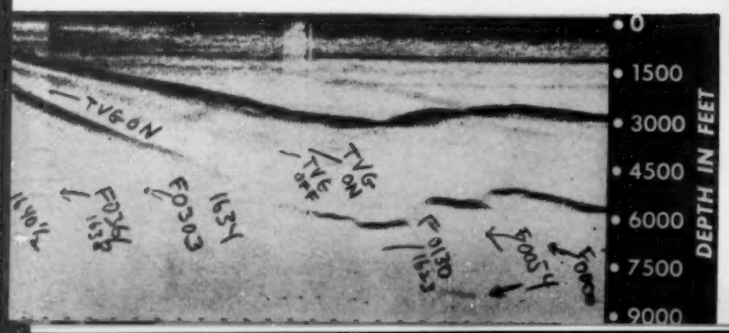
In Fig. 8 we see an anticlinal structure off San Diego. Notice again the detail brought out by the multiples.

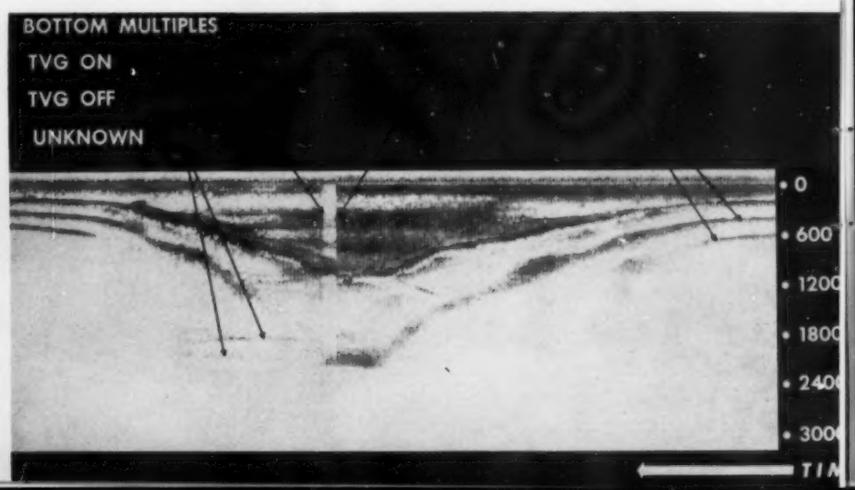
In Fig. 9 we have a typical example of the presentation as seen on the cathode-ray oscilloscope. Note how well the layering of the bottom is illustrated. The first layer appears to be hard sand overlying several hundred feet of mud and then another several hundred feet of hard sand.

Fig. 10 shows how different bottom materials appear on the 'scope. Aural listening combined with this form of presentation is quite helpful in determining type of bottom structure.

Fig. 6 (Right) Canyon on ocean floor: Note sediments on walls and horizontal strata over 1,000 ft below.

Fig. 7 (Below) Note how multiples of bottom bring out variations in ocean floor. Structure appears faulted.





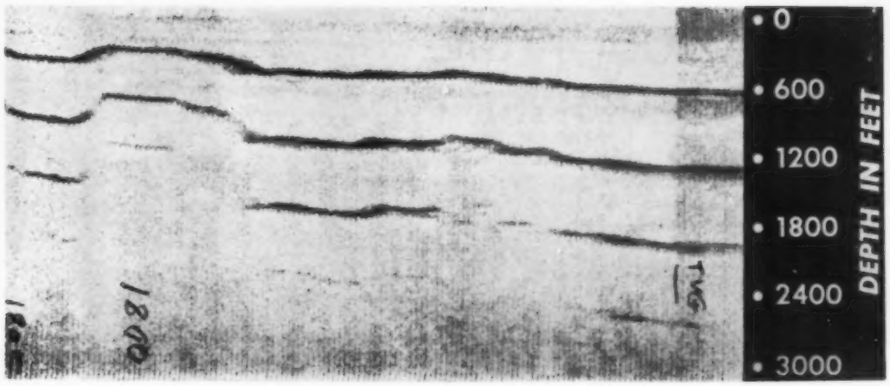


Fig. 8 Anticlinal structure on ocean floor near San Diego, Calif.: Bottom is very hard here. Note multiples.

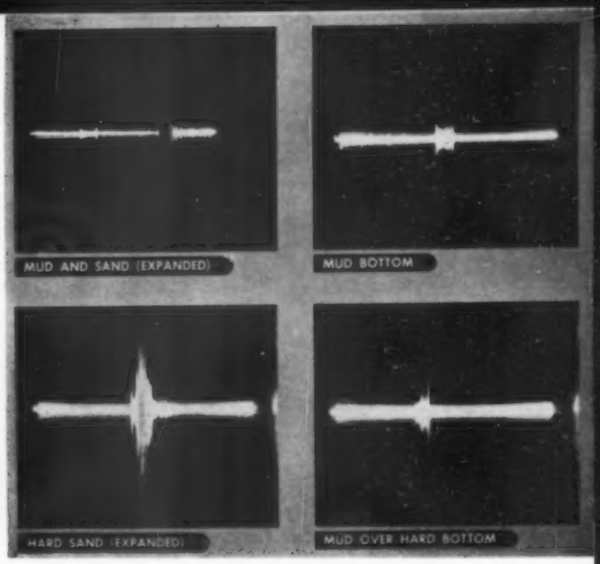


Fig. 10 Sample bottom echoes on oscilloscope.

The foregoing pretty well represent the type of records obtained with Subsurex. It is desirable to have a multitude of depth scales to choose from. The echo-expansion feature allows minute study of any one spot.

Experimental Studies Now in Progress: The eventual success of any sonic system is greatly dependent upon the sound projector. For this reason, the author has been experimenting for several years with several unconventional ways of projecting and generating low-frequency sounds. One such method is shown in Fig. 11. Here we see two large reflectors. One is used for transmitting, while the other is for receiving. In this work, the sound source is a very powerful under-water electric spark. Some seven years of work is in back of this development. A patent has been applied for. This amounts to a repeatable electrical explosion. Data on this will be published at a later date. Fig. 11 also shows a view of the electronic equipment.. Except for the reflectors, the equipment is quite small.

The newest and latest work is on a very compact high-level low-frequency sound source which can be used to replace the explosive in present seismic systems. Sound pressures have been measured, and exceed several pounds of TNT in the frequency region below 100 cycles. This is not a broadband device, but operates at a selected frequency. It is small enough to be lowered down a bore hole and carried in one's pocket! It is completely different from anything which has generated very low frequencies. Further data on this may be available in the next few months.

Conclusions: 1. High-power pulses at frequencies considerably higher than are now used in seismic surveys show great promise of obtaining much higher resolution than is now possible with conventional techniques.

2. A repetitive system is far superior to a single-shot technique such as is now used with explosives.

3. Explosive seismic techniques in general use are not satisfactory in detecting subsurface structures such as reefs, pinchouts, and thin strata where much petroleum is still thought to exist—the basic reason being that the wavelength is too long.

4. Seismic surveys using high-power sound sources can be used at many localities where explosives are prohibited.

5. It should be possible with very high resolution to actually outline the boundary limits of mineralization. This should open up new horizons in the field of geophysical exploration, since no present method can differentiate such boundary changes.

6. Explosives are a major cost in all seismic surveys. With a system such as Subsurex, savings of many thousands of dollars per month are possible. The speed of survey is greatly increased and only one boat is required, while present surveys require a small fleet of assisting craft.

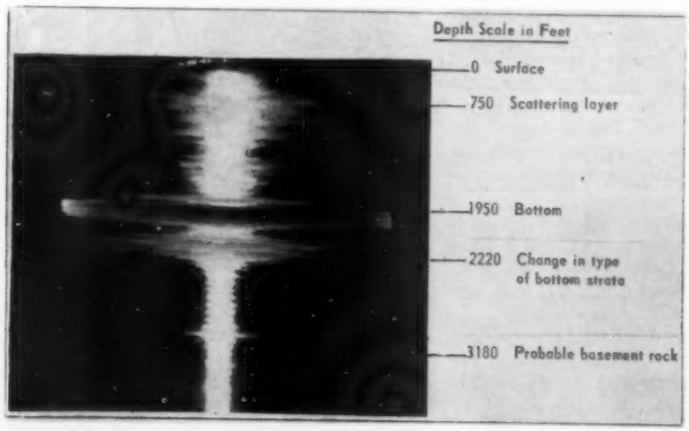
7. In offshore explorations, no fish are killed using Subsurex techniques. This item is very important to the fishing industry.

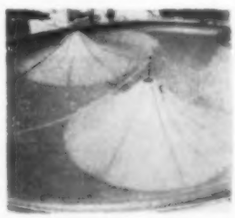
8. Subsurex offers great promise in shallow surveys for pipelines, bridge foundations, offshore-platform foundation studies, building foundations, etc.

9. With some modifications, Subsurex techniques can be used to locate land water, follow mineral veins, etc.

10. Subsurex is safe to handle. No explosives are involved. END

Fig. 9 Sample single-frame oscilloscope photo showing echoes below bottom.





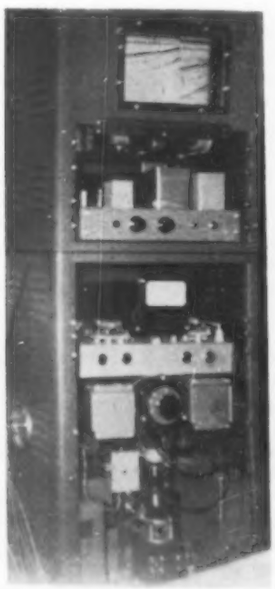
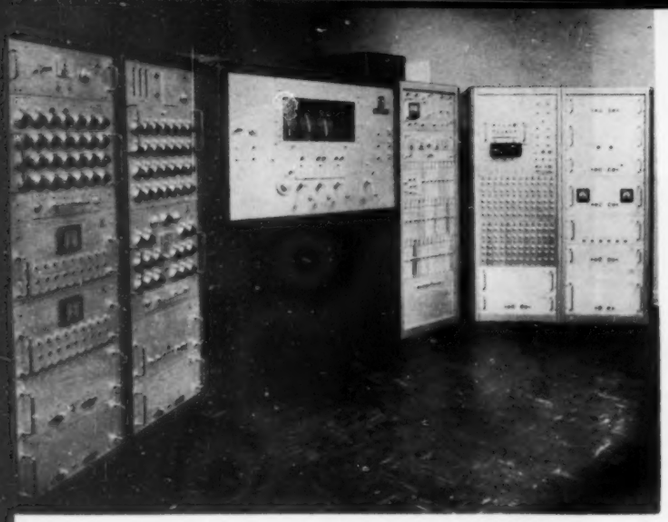


Fig. 11 Experimental model Subsurex using under-water sparks. (Above and Right)



Magnetic record analyzer for transfer of field data to corrected tapes, composition, playback and presentation in time or depth.

NEW TOOLS FOR THE GEOPHYSICIST

Magnetic record analyzer

by E. B. Tickell*

All-electronic analyzer operates as continuous computer using the analog principle.

THE basic functions of a machine for removing normal moveout from a seismic record and inserting fixed corrections are well understood in the field. These machines are designed to reduce the amount of labor and time required to produce either computed records or cross-section information; and, in areas where dip is small and other complications which tend to invalidate the basic assumptions made in their design are not too numerous, they can quickly do large-quantity good work.

While the basic function of such machines is very similar—if not identical—in the various models, the method of performing the function, or functions, is far from similar running the gamut from all-mechanical to all-electronic. Some require no information whatever from the data to be processed, while others do; and some make continuous computations, while others make computations in increments.

The Clevite magnetic record analyzer is an all-electronic, continuous computing machine which requires no information from the data to be processed. It incorporates several features intended to extend its usefulness, broaden its field of application, and simplify its operation. However, these features are in addition to its basic function of inserting fixed corrections and removing normal moveout from seismic records, and so will be described after the discussion of the sections required to perform this basic function.

The machine might best be described in terms of a simple analog computer—divided into sections for data input, computing, and data output.

*Chief Engineer, Texas Division, The Clevite Corp.

General Description: The machine is contained in five racks of electronic equipment and one section housing four tape drums. Numbered from the left front of the drum section, drums *1*, *2*, and *3* are 4 in. wide by 14 in. in diameter, accommodating 28-channel FM tapes approximately 4 in. by 42 in. Drum 4 is 1 in. wide by 8 in. in diameter, and accommodates a single-channel direct recording tape. Also associated with drum *4* are a flux-sensitive playback head and an erase head. All drums rotate on a common shaft and make one revolution in 6 sec. Head *1* is adjustable plus or minus 120 milliseconds from its zero position, by mechanical means; while heads *2* and *3* are fixed. The recording head associated with drum *4* is likewise fixed, as is the erase head. The playback head on drum *4* is positioned through a set of magnetic clutches by a servo system.

Corrections: The correction process consists of taking field information from drum *1*, correcting it in time and re-recording it onto drum *3* sequentially, beginning with channel *1*. Five seconds of corrected information are transferred; and, if desired, the normal moveout correction may be switched out, so that only datum corrections are inserted.

Composition: Compositing is done from drum *1* and *2* onto drum *3* without the use of drum *4*. This is also done sequentially. Playback is done from drum *1*, *2*, or *3*, and is simultaneous for 28 channels.

The time-corrected information produced on drum *3* in the correction process is reduced to depth information by the oscillograph in rack *5*. This is accomplished by controlling the paper drive speed in accordance with a velocity function set in on the velocity panel in rack *2*. The oscillograph may optionally be operated at constant speed to produce a time-corrected record.

1. Data input: Data input to this machine is by two separate means: (A) a magnetic tape approximately 4 in. x 42 in. containing the data to be operated upon. (B) Data insertion panels, containing potentiometers or plug-in panels into which are set the analog of data used in the operation.

Tape: The magnetic tape is a 5-plus second recording of a field shot, made in the conventional manner. This tape is placed on the No. 1, or left end drum of the four drums in the center section.

Auxiliary: Three data insertion panels are used for: (A) Fixed correction for individual traces. (B) Geophone spread data. (C) Velocity data.

Fixed correction data (elevation, weathering, etc.) are set in manually on potentiometers in the fixed correction panel in rack *2*. A range of plus or minus 150 milliseconds is available for each trace.

Geophone spread geometry data are likewise set in by means of potentiometers on the geophone spread panel in rack *1*. Individual seis distances to 6,000 ft may be set in. Provision is also made in this panel for a plug-in sub-panel which may be prewired to contain data representing spreads and distances often used. When the prewired sub-panel is used, the potentiometers are cut out of the circuit.

Velocity data are set in by means of potentiometers in the velocity panel in rack *2* with the same provision for a plug-in sub-panel as in the geophone

spread panel. Velocity functions are approximated by straight-line segments with points at 0, ½, 1, 2, 3, 4, and 5 seconds of vertical time. Average velocity range as presently incorporated is 4,000 to 25,000 ft per sec.

2. *Computing—Machine Equation:* The machine equation is derived in the customary manner from the shot geometry:

$$(1) \qquad \left(\frac{V_a T_r}{2}\right)^2 = \left(\frac{V_a T_o}{2}\right)^2 + \left(\frac{X}{2}\right)^2$$

or

$$(2) \qquad T_r^2 - T_o^2 = \left(\frac{X}{V_a}\right)^2$$

Where, T_o = one-way vertical travel time.

X = Geophone spread.

Now, let $T_r - T_o = N$ (normal moveout)

And, let W_x be a fixed time correction (to datum).

Then:

(3) $T_r = N + T_o$ (two-way uncorrected time).

Whence:

$$(4) \qquad (T_r = W_x)^2 = T_o + \left(\frac{X}{V_a}\right)^2$$

Substituting (3) in (4):

$$(5) \qquad (N + T_o = W_x)^2 = T_o^2 + \left(\frac{X}{V_a}\right)^2$$

or

$$(6) \quad N(N+2T_o) = W_x(2N+2T_o+W_x) - \frac{X_x^2}{V_a} = 0$$

Equation (6) is the form used in the machine.

In practice, the factor N in the first two terms is forced by the machine to assume the proper magnitude to keep the error E below an assigned maximum value, and is accomplished as follows:

Computing Potentiometers: A voltage analog of vertical time, $2T_o$, is generated by a potentiometer rotating with the drums. This quantity is applied to one input of a summing amplifier. To the other input is applied a voltage analog of N. The output of the amplifier thus represents an analog of the quantity $2T_o + N$. The N function is derived from the servo-driven slider of one section of a dual potentiometer. The quantity $2T_o + N$ is impressed on the top of the second section of the N potentiometer to obtain the term $N(2T_o + N)$ at the slider of the second section. Neglecting W_x for the moment, the above term represents one input to a second summing amplifier whose output must be zero if the machine equation is to be solved.

Operational Amplifiers: The other input to the summing amplifier must, of course, be the analog of the term X^2/V_a^2, which analog is developed thus:

Velocity as a function T_o time is developed as a voltage analog in the form $1/V_a^2$ by a shunted potentiometer rotating with the drums. These shunts are the values affected by insertion of velocity data into the velocity panel, discussed as follows:

The $1/V_a^2$ analog is applied to the top of a tapped resistor string (made up of either the prewired fixed resistors or the panel potentiometers) representing the X, or geophone spread information. Each tap represents one trace, or geophone location, and the quantity X/V_a^2 appears at each tap during the appropriate revolution of the drums. This analog quantity, X/V_a^2, is applied then to a second tapped string of resistors to obtain an analog of the quantity X^2/V_a^2, which forms the remaining input to the summing amplifier.

Magnetic Clutches: Should the output of this summing amplifier be other than zero, it will be fed through three operational amplifiers (for proportional control with derivative and integral stabilization) to a servo amplifier. This amplifier will, through motor-driven magnetic clutches, rotate the slider of the N potentiometer in such a direction as to reduce the summing amplifier output to zero.

The rotation mentioned is turned to a useful purpose by connecting a flux-sensitive playback head to the shaft of the N potentiometer. For a condition representing maximum N (one second), the head is advanced 60° around the drum, and for zero N the head is in its zero position. All intermediate points correspond to some particular value of N, as determined by the conditions set into the machine and by the T_o time generated. Thus, as the N potentiometer is forced to generate a voltage analog of the proper value to keep the machine equation balanced, the flux-sensitive playback head is forced to assume the proper angular position to read the tape in T_o time.

Fixed corrections are applied to each channel by rotating the body of the N potentiometer, which introduces the second term of the machine equation when W_x is not zero. W_x was applied as a correction to T_r, but T_r is defined as the sum of T_o and N, so the application of W_x to N produces the same result, and is mechanically much simpler. Actual rotation of the body of the N potentiometer is accomplished by servo-driven magnetic clutches. The input signal to the servo is set in for each channel on the fixed correction panel in rack 2.

Flux-sensitive Head: The playback head associated with drum 3 is a special type in that it is sensitive to the flux density recorded on the tape, rather than to the rate of change in flux density. A flux-sensitive head was employed to avoid the undesired amplitude effect which would be present with a conventional head if it were in motion while reading the tape.

Data Output: Output data are available from the MRA-2 in three forms: (A) Magnetic tape. (B) Oscillograph record, time or depth. (C) High-impedance high-level monitor.

Tape: The magnetic tape produced is a corrected copy of the original tape, and can be reproduced on any machine which will reproduce the original tape.

Oscilloscope: Oscillograph records are available from the corrected tape, either in vertical time or depth presentation; 28 demodulators are used to read the tape, and to drive 24 adjustable frequency filters plus four unfiltered auxiliary amplifier channels. These filters and amplifiers in turn drive the 28-channel oscillograph.

Time or depth presentation (200 ft per cm) is selected by a front-panel switch on the oscillograph.

4. *Filtering:* In addition to the equipment and functions described, there are incorporated several features intended to extend the usefulness of the machine. Adjustable filtering, for example, is available during the correction process, as well as in the 24-channel parallel-playback function.

Composition: The machine will composite tapes from drums *1* and *2* onto drum *3* in pairs, then composite the composite pairs to obtain a single tape representing four tapes. This process may be repeated almost indefinitely, if desired. Ratios other than 1:1 for drums *1* and *2* are available for compositing odd numbers of tapes.

Auxiliary Data Switching: During the compositing process, auxiliary data (time-break, uphole, and timing information) are switched and routed so that the timing signal from the first tape on the No. 1 drum is used as the timing signal on all composite tapes. The time-breaks from the composited tapes are arranged in order on the composites as follows: Time-break from tape *1* appears on trace *1;* that from tape *2* on trace *2*, etc. Uphole breaks are arranged in the same manner beginning with trace *13*. As many as eight tapes may be handled in this manner.

Simplified Control and Automatic Operation: Machine operation is completely automatic after data insertion. Pushing the cycle start button is all that is required for either the correct or composite function. In the reproduce, or playback function, the oscillograph is controlled by the drum timing system, so that the paper records are started and stopped at precisely the right time, automatically. Manual operation of the oscillograph is provided for, however.

Digital Timer: Precise alignment or offset of tapes on drums *1* and *2* is measured in tenths of milliseconds and indicated by a time-interval meter with digital readout. Sequence is also indicated. The same timer is available for fine alignment of field tapes to machine zero in the correction process.

5. *Packaging:* The machine is made up in three pairs of cabinets, so that it may be arranged in several different configurations. If space is limited, for instance, the two outer pairs of cabinets may be swung forward to form a *U*. Interconnections between cabinet pairs are made by cables and plugs, so that demounting, shipping, and reinstallation may be done in a minimum of time. Also, if it should become important to have the equipment available for rapid movement and use at several locations, its size and weight would not prevent its being mounted in a suitable van or trailer.

END

NEW TOOLS FOR THE GEOPHYSICIST

Portability stressed

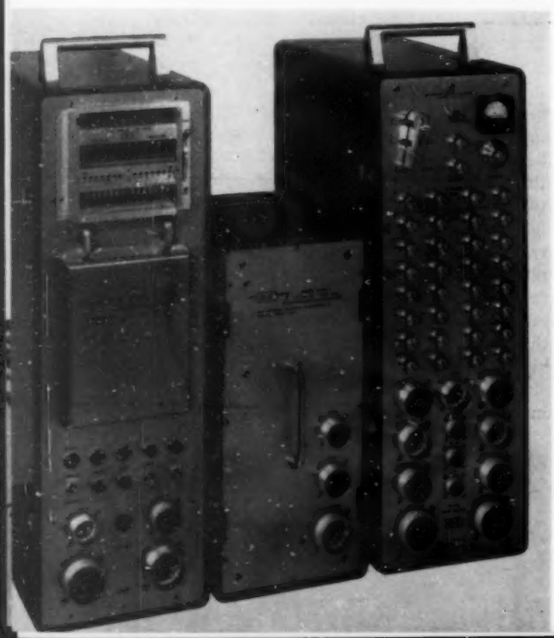
Full-spectrum seismograph systems with special moisture protection developed for use under difficult field conditions.

THE trend toward foreign exploration has created new problems for the manufacturer of seismic equipment. Where reconnaissance must be undertaken in untracked wastes, in remote jungles or rough country, the portability of equipment becomes a major factor.

Southwest Industrial Electronics Co., Houston, has developed a full-spectrum seismograph system which can be readily transported wherever a man can go. This new concept in seismic instrumentation brings the full advantages of modern recording techniques to the world's most remote and difficult areas. SIE's P-33 seismograph system can be used for reflection, refraction, or high-frequency recording with only a few moments required for switching. New amplifier circuitry and control-unit design permits fast and accurate matching prerecording adjustments.

The full-spectrum concept in the P-33 halves instrumentation investment and yet brings mixing flexibility to all three prospecting techniques. Coupled with the PMR-7 portable magnetic recorder, full-range magnetic recording equipment can be brought to the field on foot. With the wide-band recording concept in mind, outputs are provided for direct recording systems or the modulators in an FM system.

SIE model PMR-7 portable magnetic recording system.



Gain control options of AGC, non-AGC, expander, or combined AGC-expander operation insures complete dynamic control with any recording media, magnetic or photographic. Mixing method and percentage are changed quickly and easily by changing plug-in units. Dual output for recording simultaneous mixed and unmixed presentation is standard equipment. Unfiltered first-arrivals are recorded by the use of relays which switch out the low- or high-frequency filter sections until the last first-arrival has been recorded.

GA-33 geophysical amplifiers are vacuum-dried and enclosed in hermetically sealed metal cans. Ceramic tube sockets are used to provide additional protection from electrical leakage caused by moisture condensation. All connections, terminals, and wiring are protected by silicone-compound spraying. Amplifiers are replaced by simply removing two screws and unplugging the unit.

Front-panel controls adjust the GA-33 for every method of seismic recording from long-range refraction to shallow reflection. A three-position lever switch on each amplifier provides fast geophone-station checking, and is also used to connect the amplifier to the test oscillator individually. A paralleling switch connects all of the amplifiers to the oscillator simultaneously for matching.

Gain: 120-db gain is provided by five stages of amplification. Dual-element gain controls are used to permit easy matching without "hairline" adjustments and to allow precise control of overall gain. The low inherent noise level of the GA-33 amplifier allows high gain values to be employed in critical areas. Operating gain is controlled by the AGC circuit, the expander circuit, or both. Maximum operating gain is determined by the gain-control setting.

The GA-33 amplifier employs LC bandpass filtering. Two sections of filtering are employed for low-frequency rejection and two are used for high-frequency rejection. One or both of the high- and low-frequency sections are selected by toggle switches on the front panel, thus providing two attenuation rates for each setting. Hundreds of combinations are available over the range from four to 600 cycles per second.

GA-33 automatic gain control operates from a threshold value of 0.5 microvolts. The system provides maximum control over its entire range without overloading or "blocking." Three AGC time constants are selected by a front-panel control to provide the most favorable resolution with each type of recording. AGC can be turned off from the front panel for straight operation. Overcontrolling or "pinch-off" is prevented by a special filter network. Suppression voltage generated by the control unit is used to preload the AGC circuits to provide fast front-end control. A suppression control is provided at each amplifier to simplify matching.

The SIE PMR-7 portable magnetic recording system produces direct magnetic recordings on standard SIE magnetic tape. The information obtained with the PMR-7 system can be used with SIE record analysis systems, including the MS-12 GeoData system. Twenty-four seismic data channels and four information channels are provided.

The PMR-7 offers all of the direct-recording versatility and quality of large-vehicle installations; yet the complete system—including the recorder, associated electronic equipment, and power supply—weighs only 170 lb. Three men can transport the system.

The PMR-7 has a signal-to-noise ratio of 50 db RMS from 20 to 200 cps. Distortion is less than 3% at 100% modulation.

Critical electrical components in all three of the units are hermetically sealed. The recorder and amplifier cases are constructed of fibreglas, while the power supply is housed in a magnesium case.

The PMR-7 recorder utilizes a single-drum gear-driven tape transport system. The recorder also houses the recording head assembly, drive system, and the adjustable drum-mounted cams. Fixed recording heads are standard equipment, while movable heads are optional.

The tape drum is a light-weight rubber-

coated magnesium casting mounted on a shaft supported at both ends by precision bearings. Pins on the drum surface accurately locate the recording tape. The drum is gear-driven at a surface speed of 7½ in. per sec by a specially designed hysteresis synchronous motor. A high-precision gear train effectively eliminates backlash.

Recording heads are mounted, in two banks of 14 each, on a plug-in assembly which is easily removed for inspection and cleaning. Individual suspension of the heads permits alignment and pressure adjustments and this insures that each head will track correctly and still follow tape-thickness variations freely. Standard SIE head spacing is used so that records made on the PMR-7 may be played back on other SIE recorders.

The drive system is comprised of a hysteresis synchronous motor, an intermediate gear box, and a phenolic drive gear. Motor speed is precisely controlled by a 100-cps fork to give absolute timing accuracy of 0.2 millisec per sec + 1 millisecond. Adjustable cams located on the drum actuate microswitches for control functions and shot cues.

A timing check is provided by a 100-cps signal which is recorded on a separate information channel.

The PDA-2 unit contains the electronic equipment and switching circuitry for the PMR-7 system.

A front-panel meter allows continuous monitoring of recording and playback modulation. This meter also affords a visual check of recording bias. Appropriate recording or playback circuitry is selected by use of a front-panel lever switch. Operating controls are conveniently grouped on the front panel of the PDA-2. The recording playback amplifiers—including vacuum tubes, circuitry, transformers, and relays—are constructed on plug-in chassis which can be replaced quickly.

The amplifier chassis is constructed of light-weight high-strength aluminum. All relays and critical electrical components are hermetically sealed and protected against moisture. The amplifier case is of fibreglas construction and completely waterproof.

Power and timing signals for system operation are furnished by the PPS-14 power supply. The power-supply unit contains a standard 100-cps fork used as the frequency-control element for the tape-transport drive system and a dynamotor and electronic voltage regulator to supply B+. The power supply has no operating controls.

The MS-15 was designed expressly for field recording as a companion unit to the MS-12 GeoData system to provide magnetic records for the MS-12. It uses the SIE frequency-modulation method which reduces the effects of tape imperfections and wear on reproduction fidelity. Information recorded with the MS-15 can be recorded and transferred innumerable times in office-data reduction systems.

The system produces FM recordings from geophone outputs through combination seismic amplifier-FM modulator units. Except for geophones and batteries, the MS-15 is a complete magnetic recording system and field monitor. Although designed as an FM system, the MS-15 will be available in a direct recording model. The entire system is housed in two units. Transistorized power supplies are used throughout.

The MR-15 transport consists essentially of a standard SIE magnetic tape drum and a 5-in. wide oscillographic drum. The drums are keyed on a common shaft supported at both ends by precision bearings, and are rim-driven by a hysteresis synchronous motor. The SIE time aligner in the drum-drive system monitors drum speed magnetically by means of a series of notches precision-machined on the periphery of the drum. When the drum is revolving at the correct surface speed of 7½ in. per sec, this magnetic tachometer generates a 100-cps signal in a magnetic pickup. The phase relation between signal and a 100-cps signal (accurate within 1 part in 10,000) from a fork in the time aligner produces an error signal which controls the speed of the drum-drive motor. Overall accuracy of drum speed is such that timed events on successive records will compare with one another within one millisecond at any point. Precise positioning of standard SIE magnetic tapes is facilitated by pins mounted on the rubber-coated tape drum surface.

Located in the transport case are the monitor mechanism and the automatic sequencing switch which plays back one tape channel at a time. The signal from each channel is fed through a single demodulator and playback amplifier to a monitor mechanism, where it is displayed on the monitor drum. The MR-15 transport is available with either of two types of monitoring: pen-and-ink, or stylus and electrosensitive paper. All paper has preprinted timing lines.

Record-playback heads are mounted, in two banks of 14 each, on a plug-in chassis which is easily removed for inspection or cleaning. Individual head suspension permits alignment and pressure adjustment to insure that each head will track correctly and still follow tape-thickness variations freely. Optional movable heads having a range of ±50 ms for statis corrections are available.

The control console contains all electronic circuitry for the MS-15 system. Located in the unit are 12 dual-channel seismic amplifier-FM modulator combinations. Filters are provided on each amplifier to remove extraneous noise above 90 cps (wind) and below 20 cps (ground roll) . . . The filters have a linear phase shift with a zero frequency intercept of 180° to minimize character alteration. The filters can be switched to provide wide-band response from 3 cps to 500 cps. Two AGC speeds are provided, designed specifically for use with magnetic tape.

FM modulators are included on each seismic amplifier chassis to eliminate cable connections and extra housing. Modulators use the slope-modulation principle to obtain a high deviation ratio and consequently a high signal-to-noise ratio.

The SIE GA-33 seismic amplifier is incorporated in the playback network to provide maximum filtering flexibility. Since the playback process is sequential, the same amplifier is used for all 24 channels, thus assuring precise alignment for all traces.

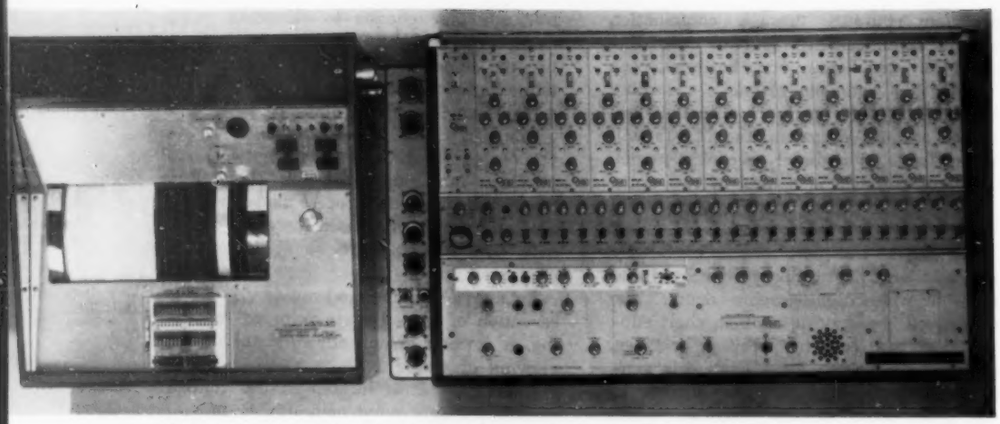
Twelve galvanometers provide visual observation of spread noise prior to recording. A selector switch allows simultaneous viewing of traces 1-12 or 13-24. A communication unit is located in the control console for shot-point communication.

Geodata Processing System: The Ms-12 GeoData processing system handles both FM and direct recorded magnetic tapes. It produces a pen-recorded time cross-section on paper which subsequently can be photographically reproduced. These time cross-sections can be isopached or set to a desired reference plane for presentation in geologically oriented form. The MS-12 can preserve the information on these final records on magnetic tape which can be duplicated any number of times or stored for future use. Final records incorporate weathering and elevation corrections, normal moveout corrections, and spread configuration information. No mechanical operations—such as the interchanging or recutting of cams—are necessary, since correction factors are generated electronically. The system handles any spread configuration, including offsets.

Any horizontal scale can be used for cross-sections, and a true scale can be presented even though spread lengths vary throughout the cross-section. Traces may be skipped as desired without leaving blank trace positions on the pen-written record. Reverse playback techniques may be employed to eliminate filter-time corrections.

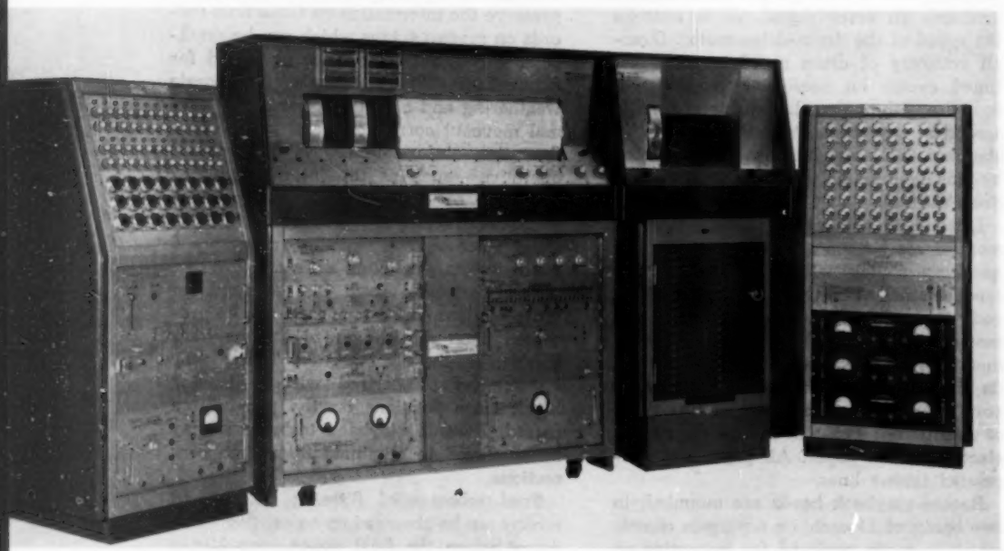
Trial schemes of filtering and record mixing can be observed on an oscillographic drum before the final paper records are made. Various weathering and elevation corrections, as well as normal moveout corrections, can be used in conjunction with mixing. Normal moveout analysis recordings and curves can be displayed to determine optimum normal moveout corrections. Use of optional accessory panel allows

Servo delay line applies time corrections necessary to remove weathering, elevation, and normal moveout from magnetic seismic records.

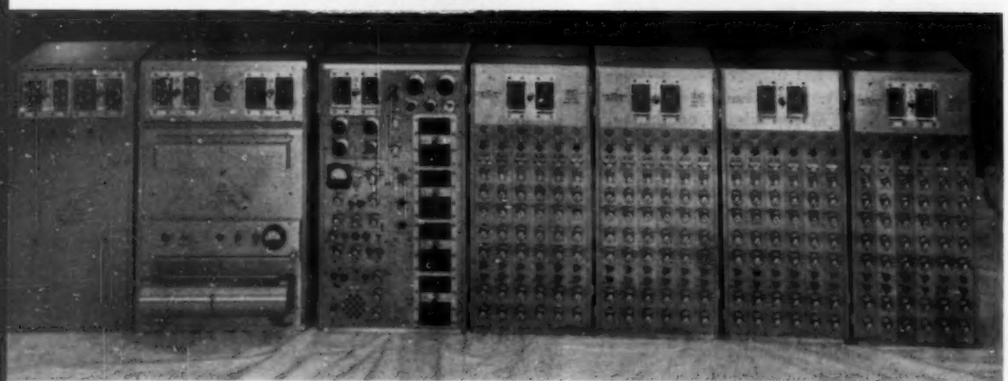


SIE model MS-15 Magnetic-seismic field recording unit: A complete two-package magnetic recording and monitor system requiring only 12 vdc power.

Geophysical data processing system and adapter for analysis, processing, and display of magnetic recordings.



SIE model P-33 portable seismograph system.



sequential compositing of corrected records.

The MS-12 system is entirely sequential in operation. One trace at a time is transcribed from a field tape to either a transfer tape, an oscillographic drum, or both. This eliminates many electronic amplifiers. Only one seismic filter is required in the system. The same circuitry is used in transcribing each channel.

The MS-12 tape transport consists of two SIE magnetic tape drums and a 24-in.-wide oscillographic recording drum, all mounted on a common shaft. Drums are indexed with respect to the shaft so that recorded signals can be properly located with respect to a desired time event (time break, uphole time, isopached reflection, etc.). A rectilinear galvanometer pen writer is provided for permanent visual display. A portion of the oscillographic drum is reserved for monitoring time break, reference signal; establishing preliminary adjustments, final filter settings, etc.

All time corrections are made by a network of potentiometers. An indicating light associated with each potentiometer indicates which trace the machine is processing. The operator can thus preset corrections for the next trace while one is being processed.

The normal moveout curve is determined by potentiometers on the NMO panel. Thirty-one controls are provided to insert the appropriate delta t corrections. More delta t correction insertion points are provided for early record times than for later ones to duplicate the NMO curve more accurately.

A proportioning panel with 24 controls, one for each seismic trace, is provided to set the correct proportion of the NMO curve for each channel depending on the spread configuration.

The information from these three panels is fed to a magnetic delay line to provide the required time correction on the record.

The magnetic delay line is the heart of the system. It consists of a small magnetic recording system in which the signal is continuously recorded and played back. The position of the playback head with reference to the recording head is controlled by the time-correction potentiometers through a servo system. Two fixed recording heads and two movable playback heads are spaced approximately 0.001 in. from the inner surface of a continuously rotating magnetic-oxide-coated drum. One pair of record-playback heads (one fixed, one movable) is used for signal information. The other record-playback pair provides noise cancelling. A maximum delay of 250 milliseconds is available. 100 milliseconds of this range (± 50 milliseconds) is used for static corrections, and the remaining 150 milliseconds is used for NMO corrections. Since the heads are not in contact with the drum, head and magnetic-oxide wear are eliminated. Timing errors introduced by dimensional variations of cross-section paper precisely correspond to the 100-cps reference signal originally recorded on the field tape. END

PROTECTION

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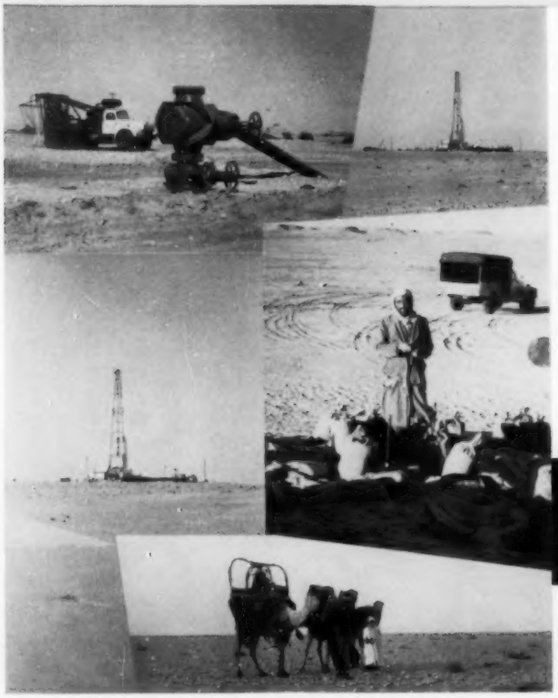

McCollum Geograph Crew at MD-1 in Hassi-Messaoud

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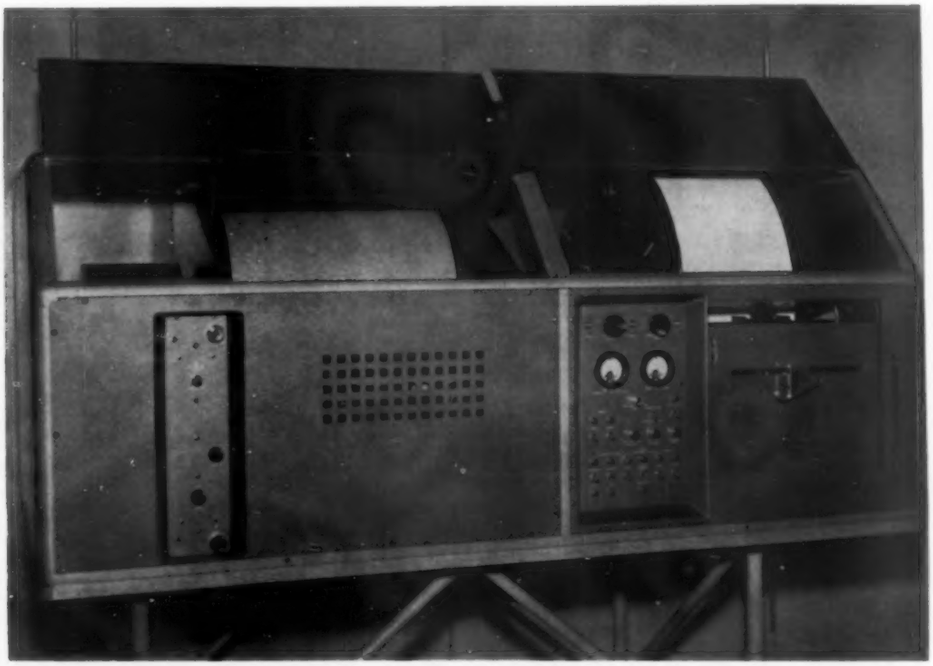
NEW TOOLS FOR THE GEOPHYSICIST

Seisverter

updates old seismic records



Seisverter may be employed to produce corrected magnetic tapes from ordinary field seismograms or directly into corrected cross-sections.

HIGHLIGHTING the research, development, and manufacturing activities at Seismograph Service Corp. in 1957 was the introduction of the new Seisverter, a device for "updating" conventional seismograms in keeping with the trend toward magnetic recordings.

The Seisverter incorporates ease in data handling, reflection-date improvement, and facility for data display, and applies them to conventionally recorded seismograms which the Seisverter compensates for timing, static and dynamic corrections, and then magnetically stores the data for future replay.

With the Seisverter, old recordings can be integrated with those taken with the modern magnetic systems.

Its use opens new possibilities in the field of seismic prospecting, the first of which is the processing of conventional seismograms so as to place them in magnetic storage; and second, to give a corrected new cross-section display.

The magnetic recordings can be replayed and presented as corrected variable-density cross-sections. If magnetic records are not desired, corrected variable-density cross-sections can be made directly from the original field records.

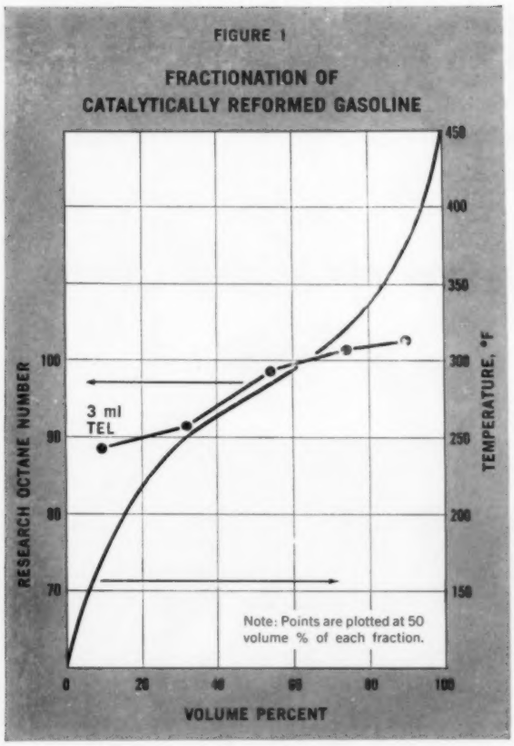
The second possibility for the Seisverter is the simplification of field recording equipment and procedures. With only slight modification, conventional seismic field instruments can produce seismograms which can be converted into magnetic storage at the field office.

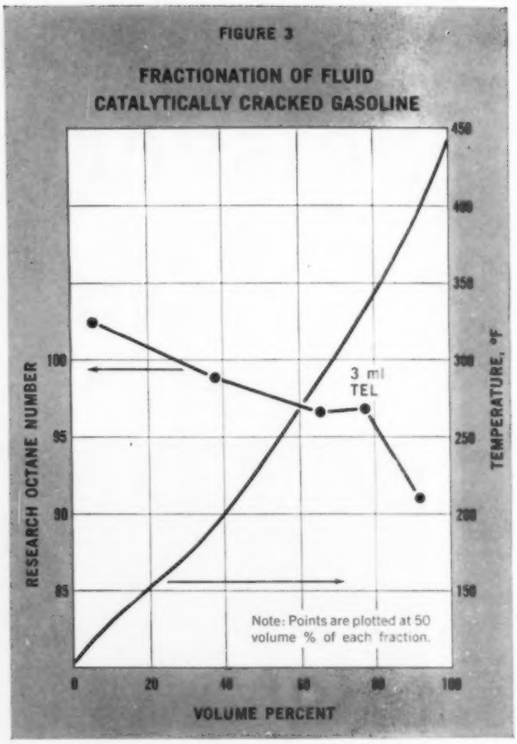
The usual corrections would be made at the time of conversion. These data would compare very favorably with those obtained with the most modern magnetic field equipment. Thus, the Seisverter turns existing field equipment which, although representing a large capital investment, would otherwise be obsolete into valuable and modern prospecting tools.

During 1957, SSC also found new uses for Lorac, (long-range accuracy), the company's pinpoint positioning system.

Among the most significant new uses for this system is the guiding of aircraft. This electronic method was used extensively for line guidance in magnetic surveys.

The Lorac data precisely determine the flight position of the plane, relating it to the recorded magnetic data. In other words, it tells the pilot where to fly the aero-





Ethyl's Octane Profiles Help Refiners Achieve More Economic Octane Numbers

FRACTIONATION of a reformate or cracked stock and an analysis of the cuts for octane and other inspection qualities by Ethyl Research Laboratories yield data that can be a very valuable tool for refiners in their continuous efforts to improve gasoline quality.

These data, referred to as "octane profiles," can be used as design bases for splitting both catalytically cracked and catalytically reformed gasolines. Such information is particularly valuable when refiners are planning how to use blending components most efficiently and economically in the production of 100 Research octane fuels.

Advantages of Splitting Reformate Are The Same As for Cracked Stock

Splitting catalytically cracked and catalytically reformed gasoline at the refinery into light and heavy fractions offers the following advantages:

1. no loss in yield

2. improves premium octane quality at low capital investment and low operating costs

3. segregates components of high anti-knock quality

4. balances premium and regular grade volatility

5. permits a milder reforming level for a given premium octane requirement with resulting yield advantage

of the fuel over the ranges fractionated.

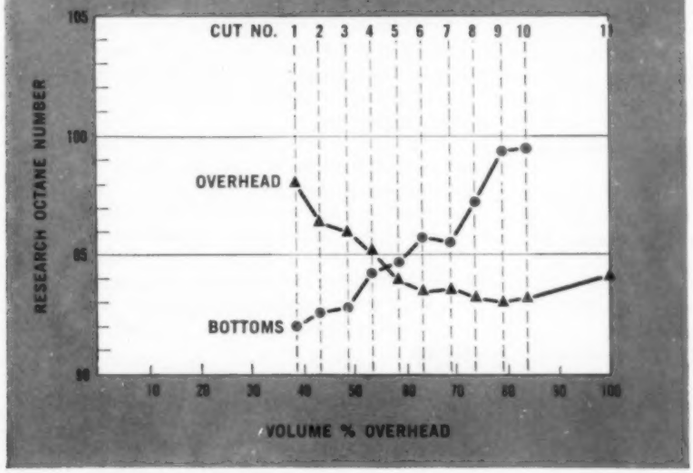
Engineers from Ethyl's Refinery Technology Group can recombine these cuts stepwise to develop a relationship as indicated below in Figure 2. This chart shows the quantity of stock that can be recombined to satisfy any given Research octane requirement.

A comparison of Figures 1 and 3 shows how catalytically cracked stocks can be handled in conjunction with catalytically reformed stocks to gain premium octane quality with balanced volatility.

The lower boiling portion of the catalytically cracked stock is combined with the higher boiling portion of the reformate. Then the remainders can be combined for use in regular grade fuel.

FIGURE 2

CALCULATED RESEARCH OCTANE NUMBERS OF CORRESPONDING OVERHEAD AND BOTTOMS



Product splitting can be a very economical way to gain additional octane quality in premium gasoline.

Reformate and Cracked Stock Cuts Can Be Recombined To Satisfy The Need for Higher Research Octane Number

Typical data for an octane profile of a reformate are shown in Figure 1.

Fractionation of the fuel that is under study into narrow cuts can be made on either a volume basis or a boiling range basis. Each cut then is subjected to a complete laboratory inspection in order to obtain the distribution of the properties

Blend 100 RON Fuels from 97 RON Base Stocks

Using data contained in an octane profile, and with the help of Ethyl Refinery Technologists, one refiner found he could produce a 100 RON blending stock (at 3.0 ml TEL/gal.) from 50 per cent of his 96 RON catalytic reformate (at 3.0 ml TEL/gal.).

Another refiner was shown that 45 per cent of his 97 RON catalytically cracked gasoline (at 3.0 ml TEL/gal.) rated in excess of 100 RON (at 3.0 ml TEL/gal.).

So, from stocks rating no higher than 97 RON, a refiner can selectively blend 100 RON gasoline yet satisfy volatility and other critical test requirements.

How Ethyl Research is helping you

Ethyl Research Laboratories in Detroit can help you evaluate the best cut points for your particular stocks.

The fractionating equipment available for this work includes 1-inch and 4-inch Oldershaw columns, 1-inch and 2-inch packed columns, and 1-barrel and 3-barrel stills.

These facilities for the close fractionation of gasoline and the services of Ethyl's Refinery Technology Group are available through your Ethyl Representative for many different kinds of studies.

These studies may include evaluation of reformer charge stocks, development of selective blending data for special boiling-range fuels, or any similar investigations you need.

ETHYL CORPORATION
New York 17, N. Y.

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RESEARCH LABORATORIES:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.

Synthetic seismic reflections are produced by this equipment from converted velocity logs.

magnetic traverse, and tells the interpreter of the data exactly where they were taken.

For such surveys, SSC's Actrac plotting device proved of great value. This instrument pilots the course of the plane during flight—or it may be used to guide the plane along a previously plotted course.

Another development for Lorac is the use of teletype for transmitting to Tulsa headquarters the rectangular coordinate positions desired for over-water exploration surveys. After convertion to hyperbolic coordinates using electronic computing methods, the data is returned to the field office by teletype.

During the year SSC continued to provide Lorac equipment and services to the military. As part of this program, the Lorac equipment has been subjected to a rigorous environmental test for ruggedness. These tests have resulted in the improvement of the reliability of the Lorac system, benefitting the users for positioning offshore oil exploration activities.

In Continuous Velocity Logging (CVL), SSC continued its program of research and development for improvement of field equipment, techniques and methods of interpretation.

Of particular interest was the development of two-receiver CVL equipment. The advantages of the dual receiver, along with improvements in the single receiver, will be made available to the industry in 1958. SSC has established new CVL field stations to better serve the oil industry. Foreign assignments in some areas are handled by portable equipment which can be flown to any location where needed. For example, during 1957, a CVL crew was flown into the Yukon to log a well inside the arctic circle.

In connection with continuous velocity logging, the SSC scale converter is finding very useful application, especially for the development of synthetic seismic reflection records from CVL data.

The scale converter is essentially a device for changing the scale of relationship of plotted data. Not only can it change the scale ratio of the coordinates of the data, but also it can relate one coordinate to the other by some mathematical function, i.e., as the integrated, the reciprocal, or the logarithmic; and it can shift the zero axis of the original data. The scale converter has considerable application in fields other than well logging.

SSC has continued to make available to the seismic exploration industry synthetic seismic records developed from CVL data.

Magnolia Petroleum Co.'s scale converter, manufactured by SSC for a variety of horizontal and vertical conversions from original field logs.

These synthetic records provide the seismologist with criteria for evaluating conventional seismic records, especially for the identification of the reflecting horizons. They are useful in conforming the seismic reflection time intervals to the geological cross-section. In unexplored territory such synthetic records, when used in connection with studies of continuous velocity logs, enable the seismologist to predict whether seismic reflections can be obtained and from what horizons.

SSC's new cross-section camera produces photographic records of seismic data as it is replayed from magnetic tape. When used with a tape reproducer which supplies corrections for weathering, elevation, and normal move-out, the camera makes seismic cross-sections which are valuable for interpretational purposes.

Information from the magnetic tapes is displayed in the form of successive recordings adjacent to one another on the same photographic sheet, using either conventional galvanometer (variable-amplitude) or variable-density traces. Optionally, through the use of a suitable optical system, variable-area traces may be made. The cross-section produced in this manner may be of a width up to 48 in. and a length of 48 in. representing a recording time of 6½ sec. for a recording speed of 7½ in. per sec.

This camera is very flexible in its conception; and, by using recording drums of different diameters and different gearing, the camera will operate with most magnetic reproducers.

Up to 240 variable-amplitude traces may be recorded using a 24-trace bank of galvanometers for each recording. The shiftover for each group recording is done automatically. When the switchover is made, the timing lines are automatically lined up and zeroed to the shooting time.

A total of 900 variable-density traces can be recorded. These are also recorded in groups.

The recording paper is attached to a rotating drum driven by a 110-volt synchronized motor. Provision is made so that the pertinent data for each bank of galvanometers may be photographically recorded on the cross-section. The photographic paper is magazined for handling.

The camera consists of two units, viz., the camera proper and the control console, which may be remotely operated. When presenting the data as variable-density traces, the usual spacing of the traces is 0.050 in. This makes it possible to show up to 900 traces on a single cross-section, which is equivalent to about 9¼ miles of profiling from 24-trace straddle-spread continuous profiling.

When the camera is used in conjunction with SSC's seismic replay console and visual display unit or similar equipment, this camera presents a cross-section of multiple traces corrected for weathering, elevation, and normal stepout. These variable-density cross-sections have proved very useful for the rapid appraisal of geologic structure. END

SSC's

complete geophysical service . . . .

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SEISMIC DATA PROCESSING AND PRESENTATION Complete instrument "centers" achieve the most effective interpretation of seismic data.

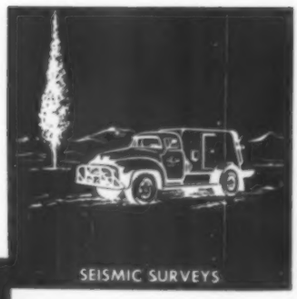
GRAVITY SURVEYS — Experienced crews, using modern methods of gravitational prospecting, provide data for SSC's new gravity interpretational techniques.

CONTINUOUS VELOCITY LOGGING — The widely accepted CVL method assures more accurate seismic surveys, and more effective borehole evaluations.

ELECTRONIC POSITIONING — LORAC provides precise positioning for geophysical, hydrographic and other surveys on land, over water and in the air.

GEOPHYSICAL INSTRUMENTS — SSC offers for sale its most advanced and proven equipment used in all phases of geophysical operations.

SSC is equipped with the experienced crews and the exploration tools necessary for the discovery of petroleum . . . anywhere. SSC is ready to serve you today.

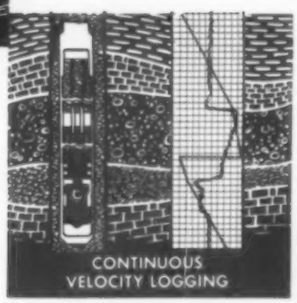

SEISMIC SURVEYS

DATA PROCESSING AND PRESENTATION

GRAVITY SURVEYS

ELECTRONIC POSITIONING

GEOPHYSICAL INSTRUMENTS


CONTINUOUS VELOCITY LOGGING

SEISMIC — GRAVITY AND MAGNETIC SURVEYS — LORAC — CONTINUOUS VELOCITY LOGGING

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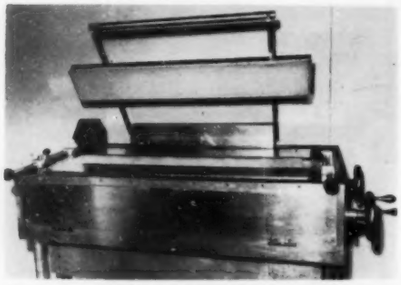
NEW TOOLS FOR THE GEOPHYSICIST

Portable seismic equipment: Central-office playback system.



Record sectioning machine, portable FA32 sesimic equipment.

Portable FA32 seismic equipment in use by a field party in Alaska.

World Wide light-weight portable gravity meter.

Portable Seismic Equipment

For seismic surveys in inaccessible and intractable areas—in desert, jungle, and mountain fastness—Western Geophysical Co. has developed a portable version of its FA 32 seismic amplifiers. The equipment has performance as high as first-line truck-mounted equipment, yet can be carried by bearers or helicopter.

Introduced in October of 1957, this equipment is now in use in Alaska and the Gulf Coast of the United States, as well as in the South American jungles and elsewhere in rough country. The unit illustrated in the accompanying photographs is in operation in Alaska in areas readily accessible only by helicopter and presenting formidable problems to seismic exploration.

Conventional stripped-down portable equipment has never, by its very nature, been capable of the standards of performance achievable with the best truck-mounted equipment. Portability of the new seismograph is achieved by combination of minaturization techniques, new concepts in electronics, and the breaking down of the unit into separate light loads.

The system breaks down into seven units, each of which is 21 x 13 x 10 inches in size. Four of the boxes weigh 42½ lb; one box weighs 41 lb, one box weighs 30½ lb, and one box weighs 30 lb.

The portable FA32 is capable of operating from 3 to 300 cycles, covering the range from refraction shooting to high-resolution reflection work. Equipped with first-break bypass and variable AVC, it may be used with or without associated light-weight magnetic tape units.

Early in 1957, Western Geophysical introduced a simple, effective, and accurate record sectioning device capable of producing continuous sections in widths up to 42 in., and with unlimited length. Later models are equipped to handle widths to 60 in.

This device is readily usable for field party offices and in foreign or remote locations, but it is equally at home in central-office playback systems. The year 1957 brought various refinements of operation control, versatility, and speed to the Western central-office playback system. This unit, with the sectioning device, can produce fully corrected seismograph record sections of various kinds. Its versatility is well attested by the diverse origins of the work handled by the four complete data-processing centers using this equipment now in operation. These centers are located in Los Angeles, Shreveport, New Orleans, and Calgary.

World Wide Gravity Meter

A new portable, quartz-elastic-system gravity meter has been developed by World-Wide Instruments Inc., Houston. The light-weight 8-lb meter has an accuracy of 0.01 milligals, and will measure approximately 100 milligals without reset. The vacuum-sealed meter system is completely temperature-compensated for use at any latitude or temperature without adjustment.

The back-lash free, digital counter dial is easy to read without removing the meter from the stand (tripod). The unit is self-contained, with no outside power source or temperature control devices. The elastic system is not clamped when transported, relieving the operator of this responsibility.

Vari-Pattern Technique

Petty Geophysical Engineering Co., San Antonio, has published a brochure describing the company's "Vari-Pattern" technique for employing multiple shot holes and geophones in difficult areas. A report on the technique was first published in *Geophysics* magazine in July 1955.

Where To Find It

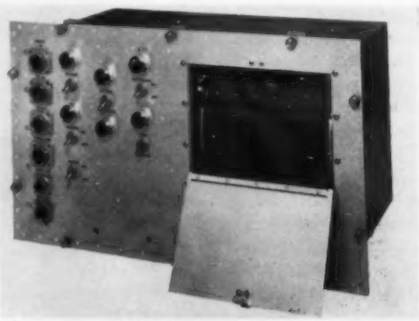
American Geological Inst. has published a newly revised and enlarged edition of its *Directory of Geological Material in North America*, by J. V. Howell and A. I. Levorsen, with the assistance of Robert H. Dott and Jane W. Wilds. The book may be ordered for $3 from the institute at 2101 Constitution Ave., Washington 25, D.C. The 208-page book lists sources of maps, reports, well records, libraries, museums in each country in North America and each US state and territory.

Geocord

A portable magnetic-tape recorder for geophysical seismic work, which features complete transistorization, light weight, and extreme portability, has been developed by General Geophysical Co., Houston. Unit is known as the Geocord.

The field unit produces standard 24-channel magnetic seismic records despite its compactness and light weight. The complete recording system is contained in two cases, each weighing 45 lb. The Geocord is hermetically sealed at every possible point, and is both water- and dust-proof.

Use of transistors in place of vacuum tubes cuts down on weight and bulk; less maintenance and repair is required in the field. Need for high voltage is eliminated, as is the necessity for a dynamotor.



Geocord

(Continued on page 80)

Rogers
Geophysical
HOW DO YOU SUPPOSE ABBIE AND DURKA ARE GETTING ALONG IN HOUSTON ?
IF ROGERS GAVE THEM THE SAME CARE THEY APPLY IN THEIR GEOPHYSICAL WORK, YOU CAN REST ASSURED THEY'RE IN GOOD HANDS.

Sam D. Rogers, President, Rogers Geophysical Company, is shown here with Abbie and Durka, the two six-months-old Hippos captured in the area where Rogers' crews are working in Somaliland and presented by Mr. Rogers to the Houston, Texas, Hermann Park Zoo.

The names, Abbie and Durka were given to the Hippos by members of Rogers Geophysical crews prior to the Hippos' departure, via air freight, from Somaliland.

Rogers *Geophysical Company*

3616 WEST ALABAMA • HOUSTON, TEXAS

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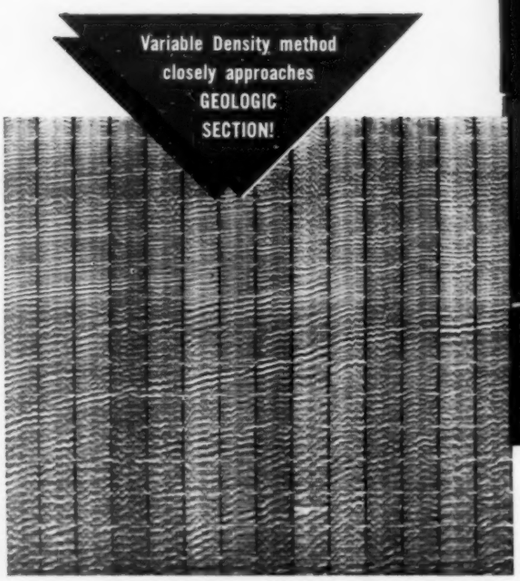
ROGERS' CREWS GO EVERYWHERE

VIP*

VARIABLE INTENSITY PLOTTER

Most rapid and economic means for time-correcting and compressing seismic data in section form!



The VARIABLE INTENSITY PLOTTER developed by Texas Instruments rapidly corrects for time or depth and compresses a mass of seismic data into section form, while preserving the relative character and contrast of recorded events. The VIP cross section closely approaches a geologic section; and is therefore readily comprehended by non-geophysical personnel.

VIP is the first *all-electronic* system devised for variable density presentations, with the added speed, reliability and accuracy which this assures. Further distinct advantages of the VARIABLE INTENSITY PLOTTER are:

1. Low initial cost—lowest processing cost per profile.
2. Operates directly from magnetic recording—no intermediate record.
3. Usable with all magnetic transducers.
4. 24 time-corrected channels simultaneously processed in one minute.
5. Inherent information retained independently of trace width.
6. Timing accuracy of ± 1 millisecond.
7. Visual examination of data on 20-inch cathode ray tube.
8. Photographic record on 2¼″ x 3¼″ negatives with obvious storage advantages.
9. Traces can be mixed.
10. Monitoring of all data possible prior to and during processing.
11. Visual indication of time and depth scale on record.
12. Easily transported—can be operated by semi-skilled personnel.

Write today for complete information, specify Bulletin No. S-322.

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INDUSTRIAL INSTRUMENTATION DIVISION
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photograph courtesy The Texas Company

Dependable data the world over

DATA QUANTITY is increased by Petty's 30 years of foreign exploration experience. Dedicated and experienced personnel plus appropriate choice of transportation result in more data per dollar.

If you are looking for oil—ANYWHERE in the world—Petty can help you find it. Call or write the nearest Petty office.

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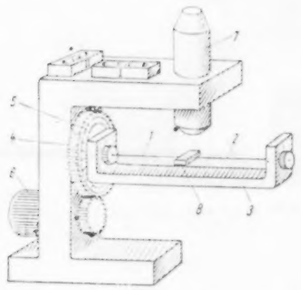
SEISMIC GRAVITY MAGNETIC / SURVEYS

SAN ANTONIO 5, TEXAS

District Offices: Houston, Tulsa, Denver, Lafayette

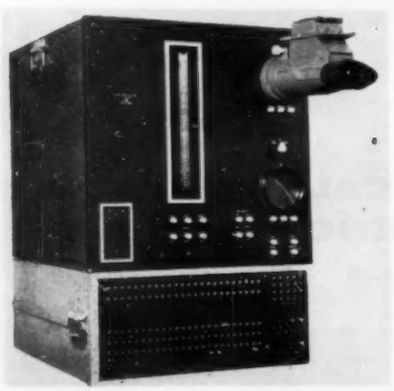
NEW TOOLS FOR THE GEOPHYSICIST

(*Continued from page 76*)



Principle of the Askania torsion magnetometer: (1) and (2) torsion fibers; (3) U-shaped magnet-system carrier; (4) torsion circle; (5) circle graduation; (6) setting knob; (7) autocollimating telescope; (8) magnet system.

Askania torsion magnetometer—Type G/2 (photo by Askania-Werke, Berlin-Friedenau, Germany).



Low-cost data processing: VIP Variable Density Plotter.

Torsion Magnetometer

Askania-Werke AG, Berlin-Friedenau, has begun commercial production this year of a torsion magnetometer for measuring the vertical component of the earth's magnetic field. A model for test purposes was described by F. Haalek at the tenth meeting of the European Association of Exploration Geophysicists in 1956, but commercial models are past just ready for market.

Magnet system of this instrument is provided with a torsion axis—in which torsion serves as a standard of measurement. When a measurement is taken, the magnetic axis of the system is brought back into the horizontal position by altering the angle of twist (null-method). The angle of twist is thus a direct measure of the vertical intensity. The instrument is within wide limits independent of the magnetic north-south direction and may, therefore, be set up in practically any position. The magnet system is temperature-compensated, well damped, and provided with an automatic clamping device. With a scale value of 25 gammas per scale division, the range of the instrument for direct measurements is 6,500 gammas. A tripod of special design enables a measurement to be taken in about one minute. The weight of the torsion magnetometer, inclusive of tripod, is only 6.4 lb.

The instrument is illustrated by an accompanying photograph and by a drawing designed to show the principle on which it operates.

Low-Cost Data Processing

A new low-cost data processing system for quick and easy processing and interpretation of seismic data was introduced by Texas Instruments Inc., Houston, at the recent annual meeting of the Society of Exploration Geophysicists.

The "VIP" (Variable Intensity Plotter) offers central processing office advantages while preserving portability. Components of the system consist of a visual display unit measuring 31 in. by 31 in. by 32 in. and weighing 65 lbs and a computing unit measuring 31 in. by 13½ in. by 32 in. and weighing 85 lbs. The two units fit together.

The system operates on 115-volt 60-cycle AC power, and requires about 2 kw.

The "VIP" displays corrected seismic data on the face of a 20-in. cathode-ray tube for easy reading and examination, and on a 5-in. cathode-ray tube for photographic recording.

The output of 24 recording channels may be processed simultaneously in a matter of seconds, after normal move-out and time-depth adjustments have been made on the plotter's control bank. Static corrections can be visually ascertained and applied. A calibrated cathode-ray tube also is provided, so that computed corrections can be accurately inserted.

Seismic sections are made easily by photographing each corrected seismogram in shot-point sequence. Records may be composited so as to improve signal-to-noise ratio.

The plotter is arranged so that the horizontal and vertical axes of the cathode-ray tube correspond to seismometer spread, and depth, respectively. An amplitude modulated signal such as the output of a magnetic recorder is applied to the Z axis, resulting in "spot" intensity modulation in proportion to the input signal—thus producing a variable-density type of display.

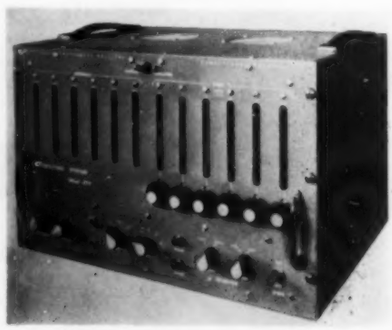
Portable Camps

Tropical and insulated camp structures for use in isolated locations where lightweight and easy portability are necessary have been developed recently by Marsh & Marine Manufacturing Co. Inc., Houston. The tropical camp is made from structural aluminum and fibreglass; it uses no screws, nuts or bolts, or any tools for assembly or disassembly. The insulated camp employs many of the basic features of the tropical camp, such as self-contained fasteners, and is made of structural aluminum and fibreglass. This unit also is completely portable, and can be furnished with either an air-conditioning unit or a heating unit.

A Marsh & Marine subsidiary company product, Plasticool, is a heat-reflecting coating which is applied in a manner similar to that of paint. This coating, available in white and several pastel shades, reflects the infrared portion of the sun's spectrum, resulting in much cooler and more comfortable working and living conditions.

All-Electronic Integrator

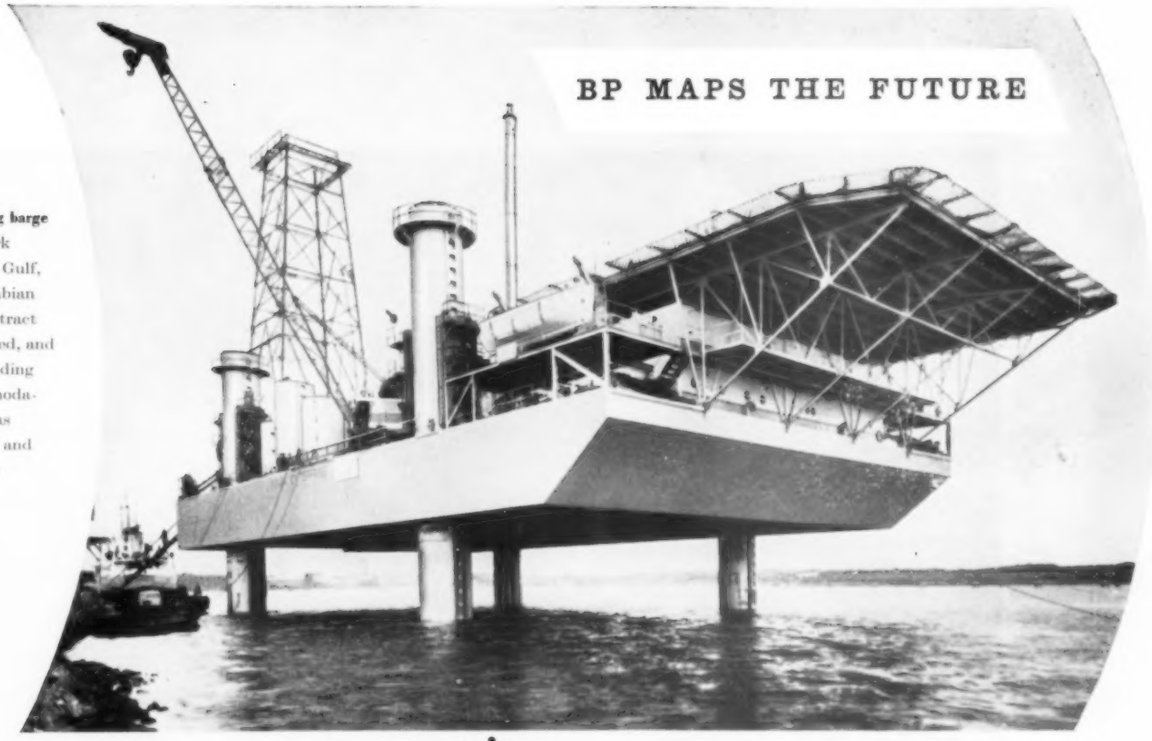
New Model 270 Integrating System, of Allegany Instrument Co., accepts analog voltage-signals; digitizes by heterodyne technique; and integrates area under signal curve by counting at rate of 10,000 per sec for high resolution of transient phenomena. Integral can be total area under curve, area above a preselected signal level, area under curve for a preselected time interval, etc. Both integral and elapsed time are displayed digitally. The instrument provides highly accurate measurements of energy by integrating power vs. time, impulse by integrating force vs. time, etc.



All-electronic integrator, model 270.

(*Continued on page 84*)

BP MAPS THE FUTURE



This underwater drilling barge will shortly be at work for BP in the Persian Gulf, 80 miles from the Arabian mainland. The legs retract to enable it to be towed, and it has a helicopter landing platform and accommodation for 50 men. It was specially built for BP and Compagnie Française des Pétroles.

Can oil supplies be doubled in the next ten years?

TODAY THE WORLD is using twice as much oil as in 1946. So far, production has kept pace with demand. At its expected rate of increase, by 1966 demand may well have doubled again. What is being done to meet this situation?

The answer is that exploration in known and suspected oil-bearing areas is proceeding on a colossal scale. In this world-wide operation the BP Group of Companies and its Associates are engaged, in some twenty countries, at an investment cost running into millions of dollars.

BP is also increasing the capacity of its fourteen refineries; adding new vessels to its 2,000,000-ton tanker fleet; expanding its marketing system, which already covers a great sweep of the globe, from Canada through Europe to Asia, to New Zealand.

In 1946 the world used a hundred and fifty million barrels of BP products; in 1956 four hundred million.

The ever-increasing demand for oil must be met: no organisation in the world is working harder to meet it than The British Petroleum Company.

THE ***British Petroleum*** *COMPANY LIMITED*

BP

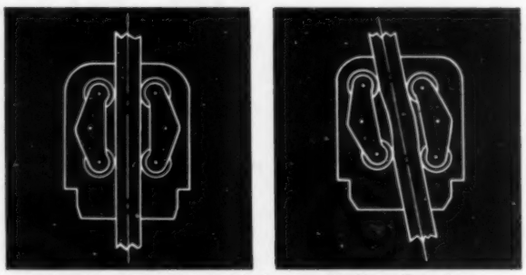
American Iron KELLY DRIVE-BUSHING

eliminates damaging Kelly whip and gyration*

SELF-ALIGNING . . . the pivoted-cage rollers in the new American Iron Kelly Drive-Bushing actually compensate for the small crooks and bends in the kelly! Now—for the first time—here is a kelly drive-bushing that assures centered kelly rotation above to the swivel . . . and below to the drill string! Unlike other multiple-roller kelly drive-bushings, the new American Iron kelly drive-bushing does not cause damaging whip and gyration movement to be transmitted to the crown block and below to the drill string!

Accurate Fit Without Adjustment at Rig!

There are no adjustments to make, no shims to put in or take out when installation is made on the kelly with the new American Iron Kelly Drive-Bushing. It helps the crew hold down-time to a minimum when changing kellys.



Exclusive Pivoted-Cage Roller Design greatly increases life of all rotating parts!

Get all the facts now from your American Iron Representative or your Supply Store man.

Self-Aligning Rollers

Four caged roller units (8 individual rollers) pivot at cage base pins to allow for nominal amount of kelly misalignment without introducing bending motion in kelly.

Positive Lubrication

All rollers are lubricated directly. No indirect lubrication system to become clogged and endanger both bushings and pins. No special grease is required.

**Resulting from misalignment of rotary table or crooked kelly.*

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PETROLEUM EQUIPMENT

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WESTINGHOUSE PRODUCTS SERVE YOUR INDUSTRY

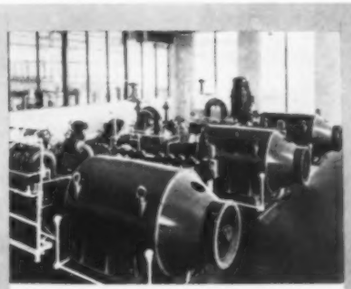
For more than three decades Westinghouse engineers have worked closely with petroleum specialists in developing new equipment to produce more barrels at lower cost. This collaboration has paid off in a complete line of electrical and motive apparatus which does a better job for the oil industry because the industry's own engineers had an important part in its design and construction. And to help you get the most from your equipment investment Westinghouse maintains an expert staff of experienced field engineers ready to assist you in solving special application problems and to supervise installation of Westinghouse equipment. *Petroleum Sales Department, Westinghouse Electric International Company, 40 Wall Street, New York 5, U.S.A.*

FROM WELL...TO PIPELINE...TO REFINERY...

Complete electrical system of this giant sea-going drilling rig was supplied by Westinghouse.

DRILLING

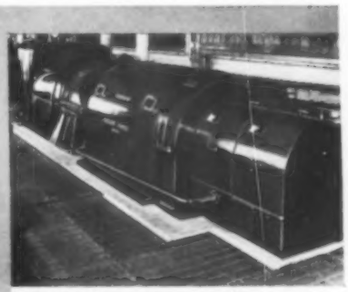
Generators
Motors
Speed Reducer
Main Controls
Driller's Console
Circuit Breakers
Lightning Arresters
Welding Equipment
Lighting Equipment



Westinghouse supplied explosion-proof motors for this modern pipeline pumping station, as well as complete electrical control system.

PRODUCTION & TRANSPORTATION

Generators
Gas Turbine for repressuring and pipeline pumping
Motors — Pumping and Pipeline
Controls
Transformers
Lightning Arresters
Corox® Oil Well Heater
Capacitors
Dynagraph
Grounding Control Equipment
Selenium Rectifiers
Microwave Equipment



Westinghouse steam-turbine generator power plant, installed in Venezuela refinery.

REFINERY

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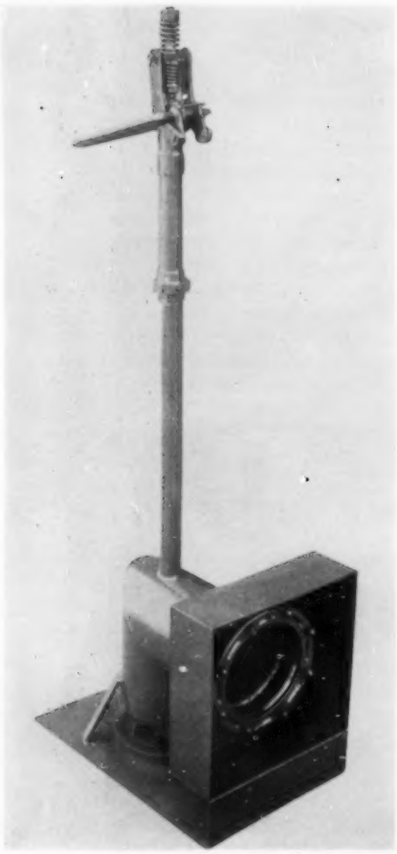
Gas Turbines
Generators
Pump Motors
Compressor Motors
Controls
Switchgear
Meters & Relays
Fans
Transformers
Circuit Breakers
Flash Evaporators
Visicode® Loading Controls

YOU CAN BE SURE...IF IT'S Westinghouse

...working partner of the oil industry

NEW TOOLS FOR THE GEOPHYSICIST

(*Continued from page 80*)



New Quick-Opening Mud Suction Valve

Portable camp: Porta-Kamp 10-ft x 10-ft model D-1-C, contained in combination case floor, a complete unit ready for shipping.

Erected D-1-C in assembled form: Awnings are fully adjustable.

Quick-Opening Suction Valve

Medearis Oil-Well Supply Co., Torrance, Calif., has a new foolproof quick-opening mud suction valve, which features a toggle action which locks itself positively—but adjustably—into closed or open position whenever the toggle is brought past center. There are no threads to gall or to be pulled. Instead, the valve is spring-loaded in both positions—thus maintaining a tension on the seal at all times. Position of the valve handle itself serves to indicate whether valve is in open or closed position.

The valve, which has been tested to 2,000 lb, is designed for full flow. The valve stem is sealed off above the top of the tank or mud line with "O" rings, and packed with grease. In the event it becomes necessary to compound the pumps against this quick-opening valve, the action can be accomplished simply by removing the spring which holds the valve in a closed position and replacing it with a 1¼-in. nipple.

A 2-in. union in the pipe housing provides an easy means of breaking the assembly down for more economical shipment. Available sizes are 6-in., 8-in., 10-in., 12-in., and 16-in.

Photo Survey Plane

Aero Design and Engineering Co., Bethany, Okla., has modified its Aero Commander planes for aerial photo and survey work. A large camera port located in the right center of the cabin floor will accommodate most single-unit vertical mapping cameras now in use. A hydraulically operated door closes the bottom of the port when the camera is not in use and protects the port when the plane is on the ground. A screw-down plate and rug cover convert the plane to executive use. The photographer has handy controls and intercom facilities near the camera location.

The Aero Commander has a high-wing swept-tail design, allowing maximum visibility for oblique as well as vertical photography. The twin-engine planes have cruising speeds of 210 to 230 mph, and a range of 1,480 to 1,625 miles. Service ceiling is 22,500 ft to 24,200 ft.

Portable Camp

Porta-Kamp Manufacturing Co., Houston, has developed highly portable camp buildings for field parties which may be packed in compact cases for transportation and quickly set up. A 10-ft by 10-ft model ready for shipping weighs 550 lb, and is enclosed in a case measuring 120 in. x 42 in. x 16 in.

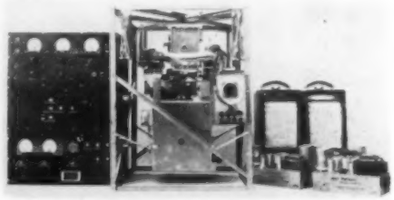
The case, itself, becomes the floor of the shelter; sides, roof and awnings are packed in the case. A complete shelter can be set up in 15 min. Aluminum screening protects against insects. Special flies are available for protection against high temperatures and insulating lines for arctic applications. Sizes range from 8 ft x 8 ft to 10 ft x 20 ft.

Gravity Meters

LaCoste and Romberg, Austin, Texas, have developed a gravity meter which gives gravity readings in a submerged submarine. The accuracy of the readings is 1 milligal. The accompanying photograph shows the components of the submarine gravity meter.

The meter will operate satisfactorily in the presence of submarine accelerations as great as 20,000 mgl., or 0.02 g. It has been operated when the submarine was surfaced when the weather was good.

The gravity meter is suspended in gimbals. Horizontal accelerations of the submarine are measured by long-period (1 min) inertia pendulums, and corrections for these horizontal accelerations are automatically computed and added to the gravity readings. Readings are made in 30 min or less.



Submarine gravity meter—including control units, gravity-measuring assembly, and recorders.

The company also manufactures an "Earth-Tide" and a geodetic gravity meter for specialized onshore purposes where a high degree of accuracy is desired.

The Earth-Tide Gravity Meter measures the diurnal variations in gravity at a fixed location. These variations are caused by varying gravitational pulls due to the sun and the moon and to variations in the earth's gravitational pull caused by slight diurnal changes in its shape (earth-tides). The magnitudes of the earth-tides are measured by calculating the effects of the sun and the moon and subtracting them from the gravity meter readings.

Earth-Tide measurements are being made with these instruments all over the world during the International Geophysical Year.

The company's new "Geodetic Gravity Meter" was designed for rough work in both oil exploration and for determination of the accurate shape of the earth. A main feature is its ability to withstand rough treatment without any adverse effect on its readings. The rough treatment does not cause sudden "jumps" or "tares" in the readings. The absence of tares makes it possible to stay away from base longer and eliminates reruns. It is even possible to put a new type meter in a deep-freeze, then rethermostat it and obtain the initial thermostated reading.

A second feature of the new gravity meter is drift under 0.5 mgl per month. A stable calibration is also an important feature, but this is not a new feature in La Coste and Romberg meters.

(*Continued on page 88*)

Yes, Virginia, gasoline does cost less than it did 30 years ago. (Before taxes, of course.) Most oilmen know this story; we know how the power in regular gasoline has climbed from 50 octane in the mid '20s to over 90 today. We know, too, what a fantastic value gasoline represents as a commodity. An industrial worker labored 23 minutes to buy a gallon in 1926; today he works just 6½ minutes for a better product. *We* know—but the public does not. What are *you* doing to tell them? **SHELL OIL COMPANY**

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REFINERY
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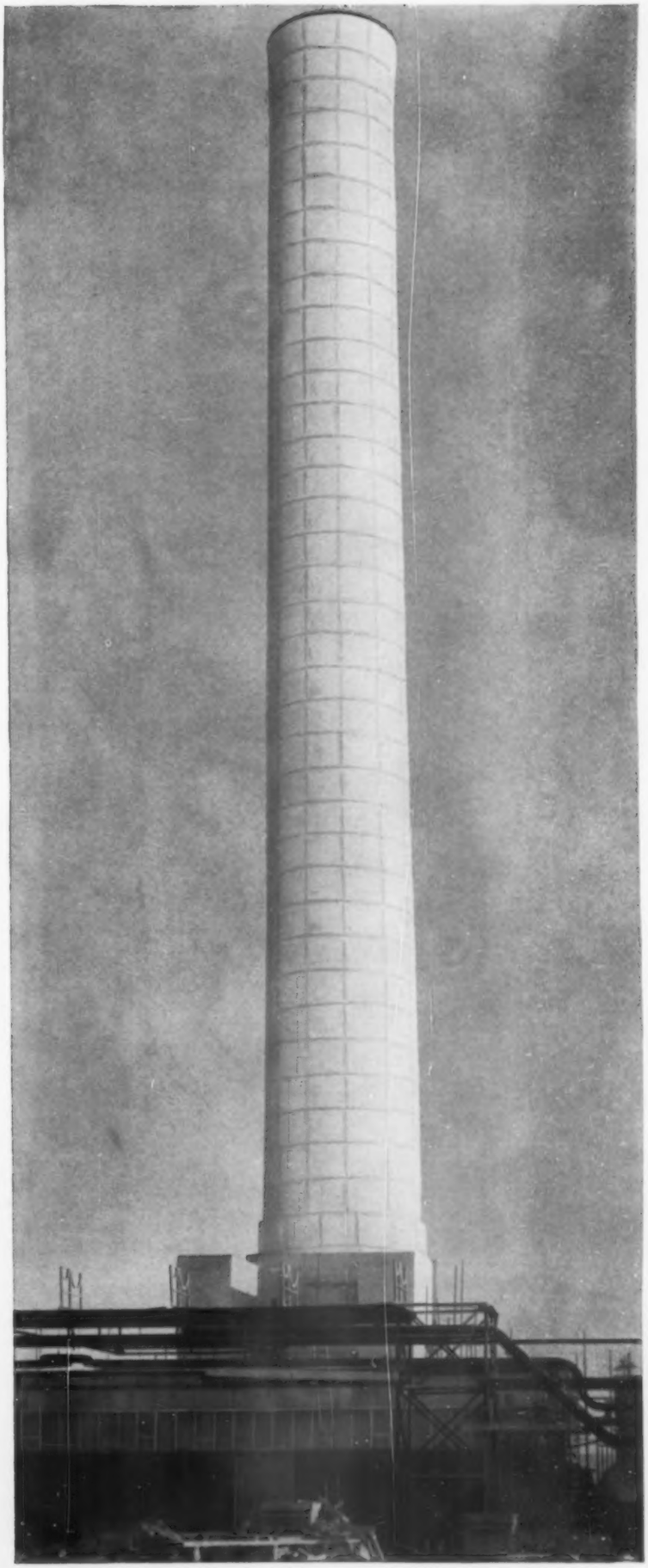
Specialists in design and construction of reinforced concrete structures for nuclear and other power stations



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TIL 9058

NEW TOOLS FOR THE GEOPHYSICIST

(*Continued from page 84*)

New Geophones

To accompany technical advances in recording and presenting seismic data, Hall-Sears Inc. turned attention to improving the somewhat neglected component of seismic instrument systems, the geophone. Both electromagnetic and electrostatic balance is typified by the HS-1 simulation (Fig. 1).

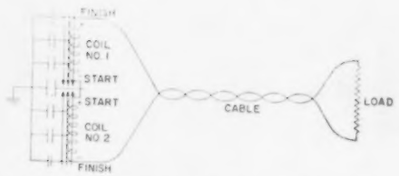


Fig. 1 New geophones: Electromagnetic and electrostatic balance typified by HS-1 simulation.

The two coils are wound in the same direction, and the two starts are tied together. For the same external field, the pickup voltage developed across the two coils will cancel. However, when the magnetic field is in the opposite directions across the two coils, as is indicated by the two arrows in Fig. 1, the voltage due to motion will add.

It will be noted that the total winding is electrostatically balanced. The smallest capacitances are tied to the cable, and the largest capacitance is tied to the center of the winding. Thus the capacitive coupling between the geophone case and each end of the winding is the same. All these factors minimize pickup from unbalance elsewhere in the system.

Fig. 2 is a cutaway drawing of the HS-1. The requirements for perfect balance were met by winding the two equal coils symmetrically on the same form and arranging the magnetic flux pattern as shown by the arrows—thus obtaining a field in one direction across one coil and in the opposite direction across the other. The end result of the interaction between the two coils is to cancel all unwanted pickup in the geophone and to add the output of the two coils which is due to longitudinal motion.

Fig. 3 is a seismic record comparing the single-coil geophones to the dual-coil HS-1. The spread cables were folded back side by side—making station No. 12 alongside station No. 13; station No. 11 alongside station No. 14, etc. The amplifier settings were the same for both banks of amplifiers, except of AC balance controls which were used on channels No. 1 through No. 12. Note the lack of 60-cycle pickup on the dual-coil HS-1. While the HS-1 is hermetically sealed, provisions were made for re-entering the case without destroying it. Since the natural frequency of the geophone is a major factor in the low-cut filtering of a seismic instrument system, this feature permits this factor to be altered to suit changing conditions without excessive costs. Access to the internal unit without destruction of the case also allows low-cost changes in winding resistance, and makes high-voltage damage repairs practical.

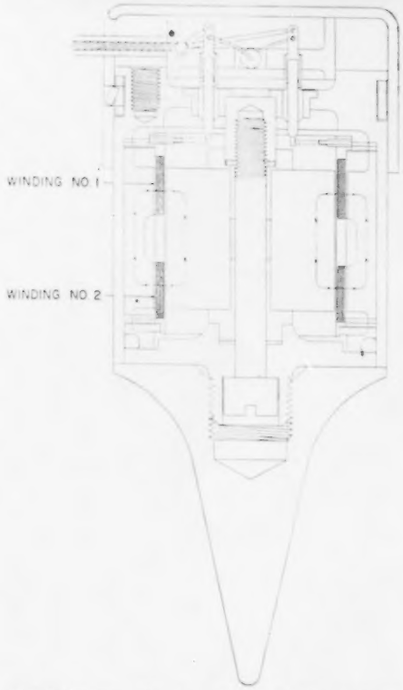


Fig. 2 Cutaway drawing of the HS-1 geophone illustrated in Fig. 1.

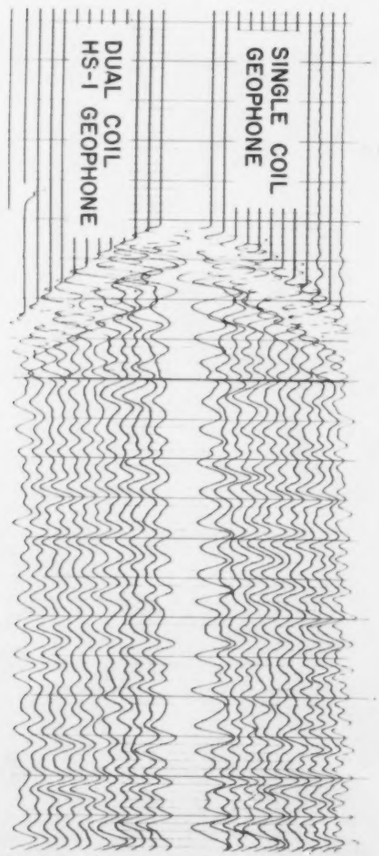


Fig. 3 Seismic record of single-coil and dual-coil HS-1 geophone.

The HS-1 was designed so that it could be made to match the output, damping, and phase responses of other standard-make miniature detectors by controlling the degree of magnetization of the high-flux permanent magnet. This permits the HS-1 to be used interchangeably with other miniature detectors. The same basic unit can be used for either land or marine operation. Merely a change of attachments is necessary to make the conversion.

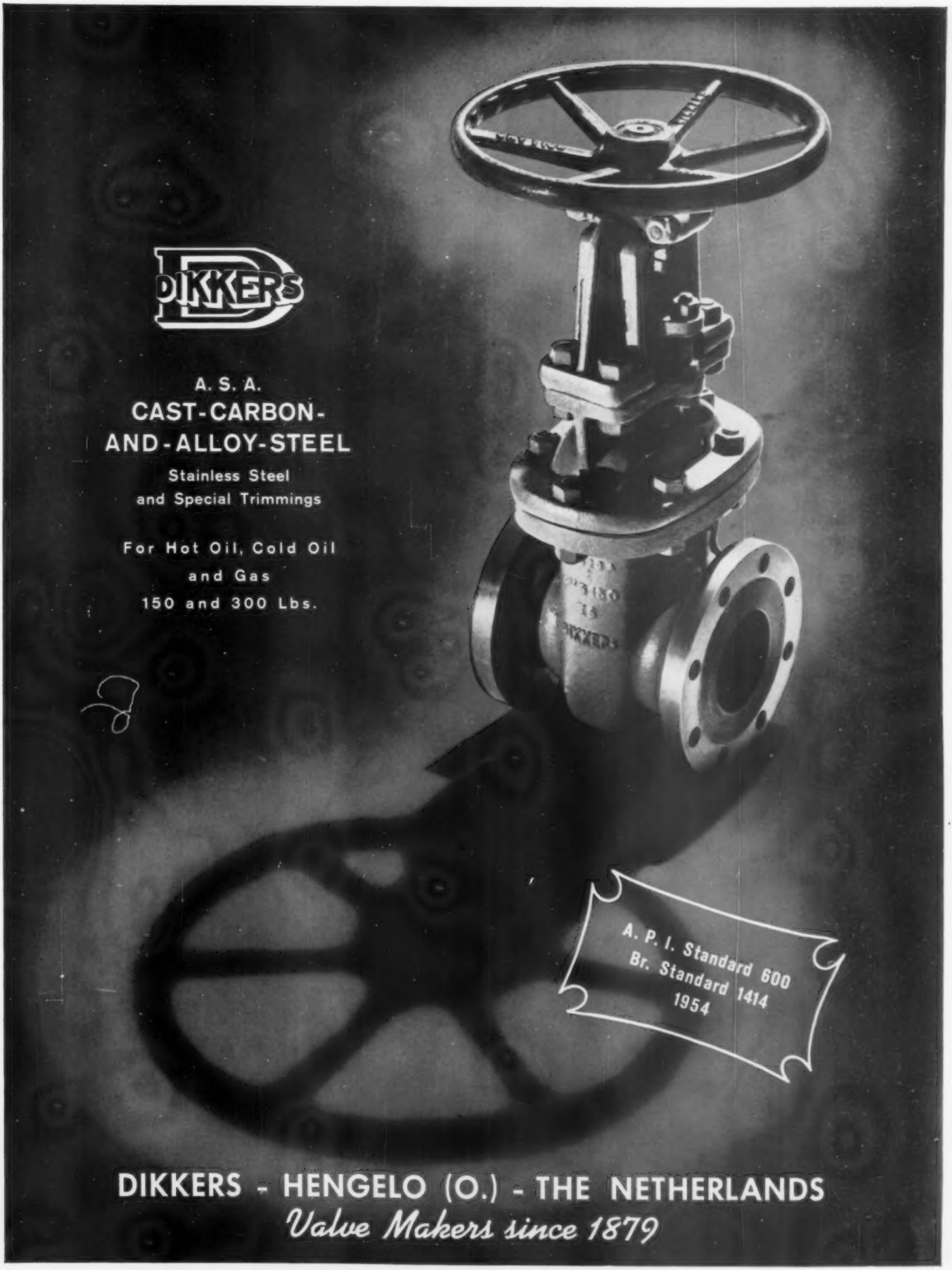
The HS-1 is available in frequencies extending from 7.5 cps to 40 cps without any change in case dimensions. A complete variety of attachments and accessories—including the new twist-lock spike—can be used for any frequency offered.

Pressure-sensitive Geophone: For the past few years, the use of pressure-sensitive geophones has continued to increase. The point now has been reached when most marsh and marine crews are using this type of geophone. Because of the improved coupling to the geophone, good results are obtained with pressure geophones where velocity geophones often gave little or no information.

When the improvement in record quality is considered, the same factors exist concerning the number of geophones to be used per trace to effect noise cancellation, regardless of whether the geophones to be used are velocity-sensitive or pressure-sensitive. However, heretofore an added practical consideration had to be given prime attention in the case of the pressure geophone. Hall-Sears Inc. also has developed the MP-1 pressure-sensitive geophone which utilizes the variable-reluctance principle. Each unit is provided with two diaphragms—one on each end. Out-of-phase movements of the diaphragms tend to cancel—thereby reducing noise due to random pressure changes caused by movement or other disturbances in the water. There are no moving coils or other high-inertia elements used. The standard impedance of the winding is 215 ohms.

The MP-1 is rugged and easy to handle. It is still operative at 1,000-ft depths. The complete unit is rubber-plated, which serves to damp any oscillations, and the natural frequency is above 1,200 cps at atmospheric pressure. The natural frequency increases with pressure. However, the characteristic decrease in sensitivity with increases in depth is not so pronounced in the MP-1. The arrangement of the diaphragms and magnetic circuit makes the unit more efficient for a given movement of the diaphragm when operating at greater depths.

(*Continued on page 92*)



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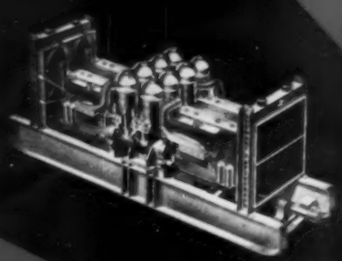

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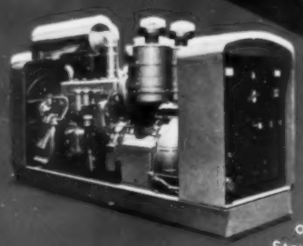

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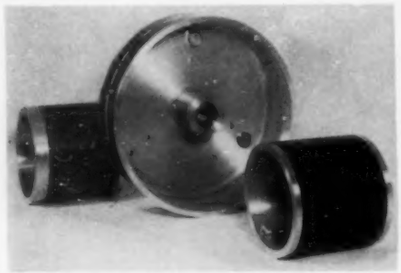
NEW TOOLS FOR THE GEOPHYSICIST

(*Continued from page 88*)

The Omnitape is compact in design—occupying little floor space.



Speed changes are accomplished by using drums of various sizes.

Marine gravity meter.

Omnitape Transcribing System

Since the introduction of records on magnetic tape, the seismic industry has had opened to it vast, new areas of information. But with its advantages have come problems. One of the earliest problems recognized was that of a standard tape . . . a standard system of recording. However, since each seismic operator has different needs, it follows that one standard system has not yet been feasible. This situation is the gene that caused the development of the Omnitape by Hale Instruments Inc., Houston.

It is the purpose of the Omnitape to transfer data from one major magnetic tape to another. In accomplishing this, five major problems are involved.

The first is to get the tape transports of the various systems in sychronism; i.e., both rotating together in order to line up the shot points on the tapes. This is done by putting both transports on one shaft ($3\frac{1}{2}$-OD stainless steel) and driving the shaft with one gear box.

This introduces the next problem—that of various speeds, i.e. 3.59, 3.75, and 7.5 in. per sec. To handle this, the basic RPM of the shaft is one which will give a speed of 3.59 in. per sec on the periphery of a drum 7.5 in. in diameter. From this RPM is calculated the necessary outside diameter of drums to give any other peripheral speed necessary. For the three speeds mentioned above, three drums of different OD would be furnished.

The next question is how shall differences in track spacing be handled? The answer is to use a single magnetic head and transcribe one trace at a time with a move-over rack to control the sequence of the head across the tape. For this control, move-over racks with tooth spacing of $\frac{1}{16}$ in., $\frac{1}{8}$ in., $\frac{3}{16}$ in., and $\frac{1}{4}$ in. were developed.

Now, because of the very narrow track spacing in some cases, a fourth problem presents itself. Because of the physical impossibility to get the magnetic heads close enough to each other, those tapes with very narrow track spacing are *interlaced*; i.e., a bank of 14 heads in one position on the tape and the next 14 in a bank several hundred milliseconds around the tape. The heads in this second bank are so spaced that they will record between the tracks of the first bank—thus the term interlaced. To meet this, a scale and vernier graduated in milliseconds allows the second bank to be brought up to the datum established by the first bank of heads.

The final major point was the different types of electronic recording involved; i.e., amplitude modulation, frequency modulation, and pulse width modulation. This was easily solved by using electronics peculiar to each various system.

Putting this together, transcribing is done with a single playback head transcribing one track at a time to a single recording head, with the heads automatically moving over to the next track. All the electronics for this is accomplished through demodulators and modulators peculiar to the various systems. All drum speeds are constant and compatible with peripheral speeds at the time of recording.

At the present, the following systems are available on the Omnitape: Carter Pulse Width System, Electro Tech DS 7 (AM), Electrodynamic FMR 30 (FM), Electrodynamic DR 30 (AM), SIE MR 4 (FM), SIE PMR 6 (AM), and Techno TI-450 (AM). Generally speaking, however, any system which uses a drum transport and is recorded at any constant speed between 3 and 7.5 in. per sec can be handled on a standard unit. A maximum of 6 sec of useful data may be transcribed. In addition, modifications are being made to handle the Texas Instrument, MagneDisc, will be available in the next 6 to 12 months.

Geo-Logger

Well Reconnaissance Inc., Dallas, has developed the portable Geo-Logger for core-hole and stratigraphic-test programs. Manufacturers refer to the logger as a "do it yourself" unit. Both gamma-ray and electric logs can be run with an outfit small enough to fit into the trunk compartment of most automobiles. Interchangeable components simplify the equipment. The recording unit is of the instantaneous developing photographic type. As a "turnkey" unit, Well Reconnaissance supplies a portable gasoline-driven electric-generator power source with suitable accessories. Units are made for 3,000-ft and 6,000-ft service.

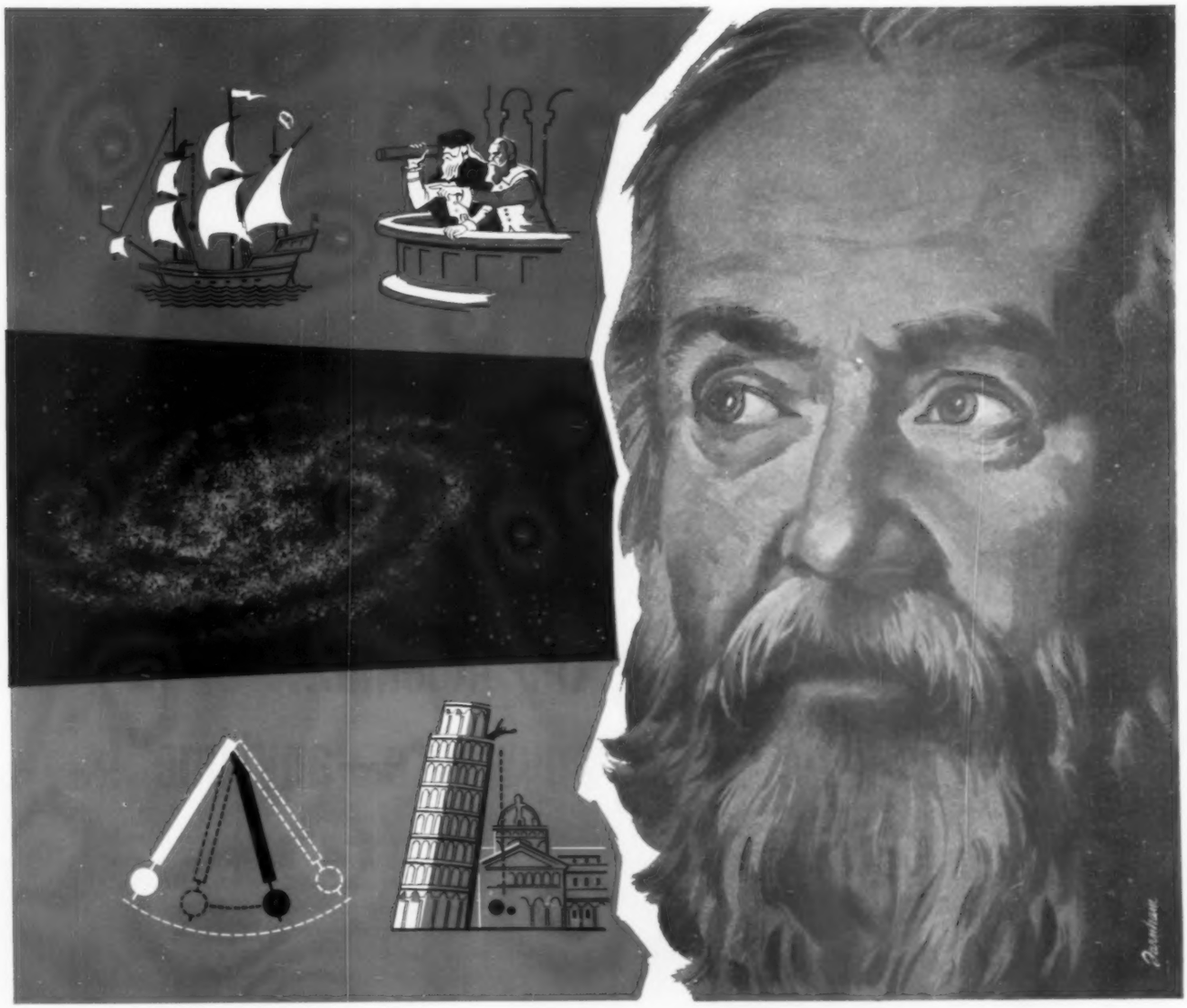
Marine Gravity Meter

North American Geophysical Co. has announced its Model UW-2R Marine Gravity Meter—a remote-reading self-leveling under-water instrument, submersible to 800 ft of water. Depth indication is accurate to half of one percent. This instrument will obtain accurate data within 0.01 milligal. The operator at the console easily controls all functions—with all functions metered. Resetting the meter to within reading range is simple and positive.

Enlarges Bit Line

Herb J. Hawthorne Inc. has enlarged its line of bits for seismic exploration through the purchase of all facilities and rights of the National Oil Tool Co., Wichita, Kans. The national cone-type rock bit for harder formation drilling supplements Mr. Hawthorne's "Blue Demon" line of blades for soft, medium, and medium-hard formations. Through purchase of the National plant, Mr. Hawthorne obtained a Bullard six-spindle vertical lathe and a number of other highly developed machine tools for accurate multiple operations. Equipment purchased included facilities for heat treating, deep carburizing, and hard-facing.

(*Continued on page 96*)



Scientific Coordination. Galileo coordinated the knowledge of his day to produce thought changing data for modern science. General Geophysical has coordinated its manufacturing, laboratory, and field exploration facilities to produce *accurate data* for its clients' decisions. General's engineers design and build reliable recording equipment that is easily serviced in the field. The laboratory tests, *then retests* each unit for precision performance. General's field crews are fully informed personnel, trained to proficiently operate and maintain the equipment they use. With General's coordinated geophysical services on the job *you know* that your reference data are exactingly correct.

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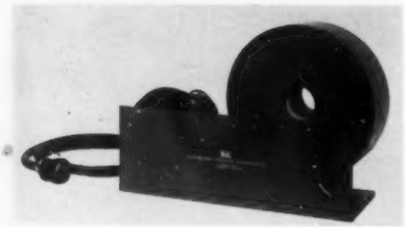
NEW TOOLS FOR THE GEOPHYSICIST

(*Continued from page 92*)



Model MTE-2 magnetic-tape eraser for direct or FM recorded tape.

Magnetic-Tape Eraser

The MTE-2 magnetic-tape eraser was designed by Southwestern Industrial Electronics Co. to provide clean demagnetization of either direct or FM recorded tapes. The unit allows tapes to be erased without removing them from their containers. It can be used to demagnetize any magnetic tape which can be rolled to a diameter of 1½ in. Tapes magnetized at any level can be completely erased. Routine use of this machine will avoid the possibility of obtaining bad magnetic field records if tapes have been improperly stored in the proximity of high magnetic fields.

Program Scanner converts drawn curve into voltage.

Converts Drawn Curve into Voltage

A new nonmechanical instrument which converts a curve drawn on graph paper into a voltage has been developed by Spar Engineering & Development Inc., Wyncote, Pa. The all-electronic unit, known as the Program Scanner, operates when a photographic transparency of a curve is inserted in front of the "flying spot" tube which is swept by a vertical line moved horizontally across the face of the tube. The photomultiplier circuit in the scanner acts as a switch, sees the "flying spot" during the time it is below the curve, and turns on and off a Schmidt trigger, which has its output clamped to a glow-tube reference to produce constant-amplitude variable-width pulses. The unit does not have the same speed limitations as electromechanical devices. The new scanner's output is available as a variable-width pulse or DC—with AC output being obtained by adding a converter. Accessory items include an automatic camera to facilitate the making of transparencies, and time-base generators to drive the horizontal sweep.

Amphibious instrument barge and tractor.

Instrument Barge and Tractor

Amphibious instrument barge and tractor manufactured by Applied Research and Development Co., Houston, for operation in difficult terrain such as mud flats, rice fields, or sand dunes. The company manufactures all-aluminum barges for transporting instruments, drills, cables, and general equipment.

Model 200 Recorder.

Model 200 Recorder

Mount Sopris Instrument Corp. has announced a transistorized, dual-pen, strip-chart recorder of the servo-driven, self-balancing potentiometer type.

The two pens share the width of the 5-in. chart, and are mounted in line to provide correlation of the measurements being recorded. The span of either pen may be adjusted to occupy from 25% to 75% of the chart width, with the second pen occupying the remainder. The sensitivity is 10 millivolts full-scale for either channel when the span adjustment is such that each pen covers one-half the chart width. Under these conditions, each pen has a full-scale response of 0.25 sec, with negligible overshoot. The linearity is within 0.5%.

Portable Magnetometer

Varian Associates, Palo Alto, Calif., has begun commercial production of a transistorized portable version of its magnetometer reduced in size to 9$^{15}/_{16}$ in. by 9½ in. The original 250-lb station model has been reduced to 15-lb. Enclosed in a leather case, it is designed to be carried at the prospector's waist.

Two separate parts of the M-49 are the "coil-and-sample" or sensing head, which consists of a coil of wire surrounding a bottle of liquid containing hydrogen atoms; and the electronic portion, which unravels the sensing head's signals and provides measurements of the earth's magnetism on a meter. The two parts are connected by a cable, which will disconnect before the strain becomes great enough to damage the instrument if the cable is accidentally snagged.

The instrument has been designed to survive severe jolts and continue operation. It is sealed to prevent water damage to the intricate circuitry. It will continue to operate in falling snow, or in hot humid areas; through thick underbrush, muskeg, or over granite outcrops without special compensation.

All control dials can be operated with gloved hands; yet they are streamlined to prevent snagging in undergrowth. The meter is prominently displayed—making it easy to take readings at a glance.

The M-49 is insensitive to its physical orientation in the earth's magnetic field. No preliminary leveling or orientation is required for either the sensing head or the electronic portion. This means the instrument can be operated from an unstable platform—on foot, in a boat, in a balloon, or even on horseback. The sensing head may be operated at a considerable distance from the electronic device.

Another marked advantage is the rapidity with which surveys can be made. Operations in the field have demonstrated that readings can be made as rapidly as the operator can record them.

With the M-49, the operator can choose automatic or manual polarization by the turn of a knob. When the instrument is set for automatic, it will provide readings at a 6-sec repetition rate while the operator moves over an area and records magnetic data. Manual control requires the operator to press a button for readings. This conserves battery power to permit extended trips away from the base camp. Batteries may be recharged overnight from a 6-volt automobile battery.

Plug-in units are available to extend the range to cover the broad variation in magnetic fields at different points on the globe. By selecting the proper plug-in units, the instrument can be operated anywhere in the world.

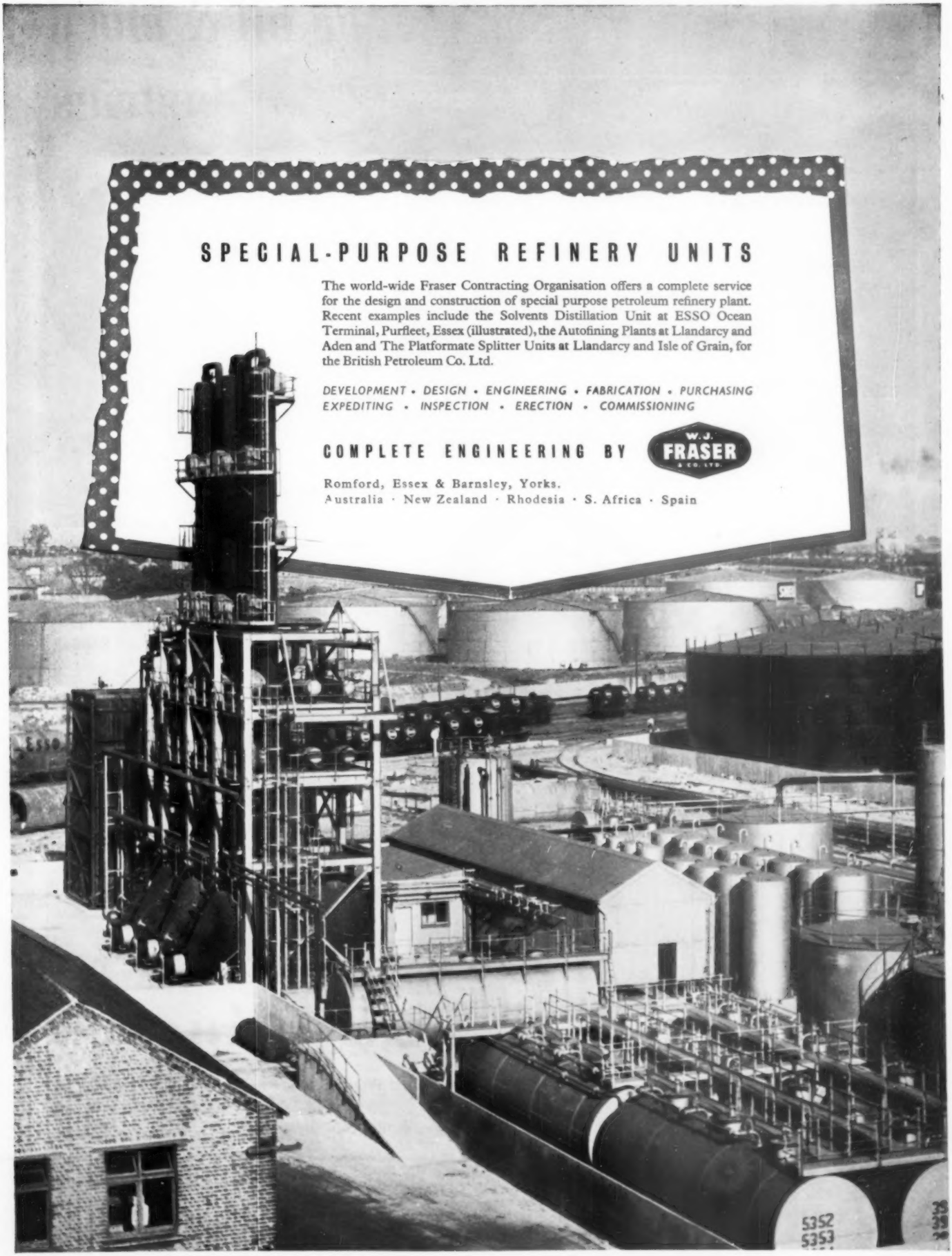
In addition to the visual readout in gammas, the unit is equipped with crystal earphones which will enable the operator to monitor the precision signal by change in pitch.

First announcement of the portable magnetometer was made at the recent SEG meeting. At that time, it was stated commercial models would be available early in 1958 and worldwide distribution undertaken.

Electric-Log Service

Panhandle Electrical Log Service, Amarillo, Texas, has published its 1958 catalogue of all electrical and radioactivity logs released to the oil industry to October 29, 1958—by counties, by fields, and by wildcat and development wells, covering the Panhandle of Texas and Oklahoma and the adjoining areas in Colorado and New Mexico.

(*Continued on page 100*)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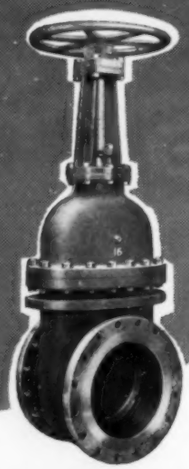

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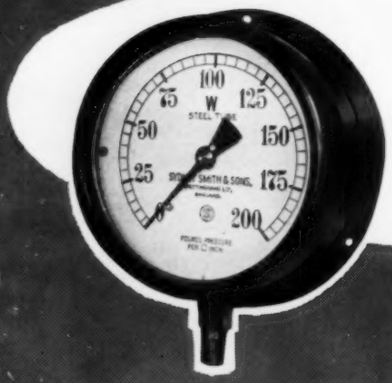

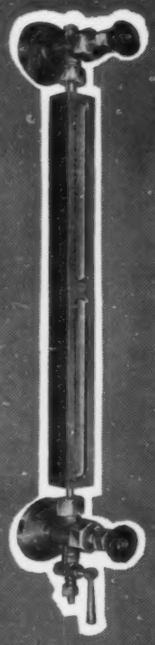

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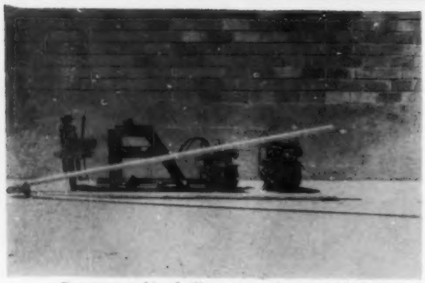
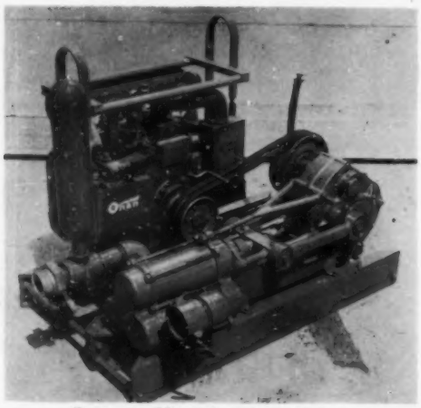
NEW TOOLS FOR THE GEOPHYSICIST

(Continued from page 96)



Petty portable drilling unit, disassembled.



Petty portable mud pump with motor.

Portable Drill and Pump

Petty Laboratories, San Antonio, Texas, have developed highly portable equipment for shot-hole drilling in difficult terrain. The Model 54 drill consists of five basic parts with a total weight of 488 lb, including the engine. The engine is the heaviest item—weighing 130 lb. The rotary table weighs 125 lb, the chain case assembly 97 lb, the frame assembly 68 lb, and the mast assembly 51 lb. Rated capacity is 100 ft to 125 ft, with 3½-in. bit. The unit can be set up or disassembled in about 5 min.

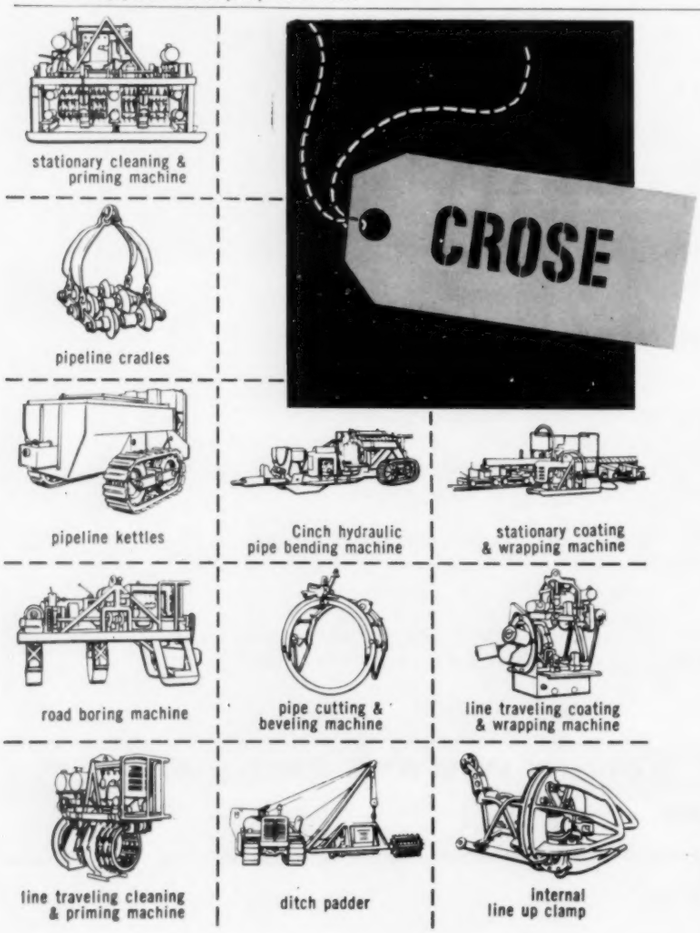
For use with the drilling rig, Model 53 portable pump weighs 311 lb, including the engine. The engine assembly weighs 159 lb and the pump end 152 lb. Petty first created the portable drilling outfit 20 years ago, and has continued to develop subsequent models with lighter metals and more compact design.

Mobile Vari-Plotter

Petty Geophysical Engineering Co. has started operation of a new seismic exploration service which makes use of a mobile unit with integrating equipment which serves the dual functions of field recording and data processing on playback.

During the day, the unit functions as a magnetic field recording truck. At night, office personnel operate the equipment to make corrected playbacks of the preceding day's work for which the appropriate corrections have been computed. All functions of the playback process are completely checked, and the corrected and checked playback records are then assembled into a completely corrected record section for interpretation. Since this mobile unit elminates tedious hand plotting of record data, and has the facility of applying variable corrections to the photographically plotted data, the descriptive name "Mobile Vari-Plotter" has been adopted.

Synchronized timing and automatic photographic scaling of field and playback records are employed to reduce office duties so that the playbacks can be made without additional personnel in most cases. This type of operation is feasible whenever the operating equipment can be returned to base during off hours, and is economical because the investment in capital equipment is increased only by the cost of the variable correction unit. All other components serve equally for playback and recording purposes.



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London Letter

(Continued from page 12)

tinue to be available for special duties as deputy chairman. He is succeeded by H. C. Pritchard, formerly of Elliott Bros., who has had a distinguished scientific career from the time he achieved high honors at Oxford until his appointment as chief superintendent of the Woomera Rocket Range in Australia.

Tanker News

Gotaverken, Goteborg, Sweden, has launched the 19, 250 dwt motor tanker "Ternoy" built for Skibe A/S Truma, Arendal, Norway, and delivery of the turbine tanker "Nanny" of 34,000 dwt, built for Rederi AB Monacus, Kungsbacka, Sweden.

In their annual shipbuilding return of vessels launched 1957, Furness Shipbuilding Co. Ltd. include the following steam-turbine tankers: "London Tradition" and "London Resolution"—each of 16,275 gross tonnage; "Violetta" and "San Edmundo" each of 11,930 gross tons. All these ships are registered in London, with the exception of "Violetta" built for Santiago Societead Armadora SA and registered in Monrovia. It is notable that she is the 162nd tanker to be constructed by this shipbuilding company.

The turbine tanker "British Faith" was launched at the Barrow-in-Furness shipyards of Vickers-Armstrong, December 10, 1957—her sponsor being Mrs. Eadie, wife of Mr. W. E. Eadie, chairman of Burmah Oil Co. Ltd., and a director of the British Petroleum Co. Ltd. This ship of 32,000 dwt is the second of two sister ships built for the B. P. Tanker Co. Ltd.

The motor tanker "Hegh Foam," of 24,700 dwt, for Leif Hegh & Co. A/S, Oslo, Norway, was launched from the shipyard of Cockerill-Ougree at Hoboken, Belgium, December 3, 1957.

New Welding Set

The British Oxygen Group of Companies announces a new quasi-arc single-operator engine-driven welding set; a heavy-duty straining frame for testing structural materials, including reinforced beams; and new testing equipment for blowpipes.

Mobile Drilling Platform for Royal Dutch-Shell

A new mobile drilling platform equipped with helicopter deck and a 75-ton crane has been ordered by Royal Dutch-Shell from NV Werf Gusto, Schiedam, Holland, to replace the one damaged beyond repair in a violent storm off Qatar, in the Persian Gulf, in December 1956. The new unit, which is to be delivered by the end of 1958, has been designed for operations in all the group's offshore concessions, and will be of the elevator-type which has a floating hull. It will be capable of drilling in water from 20 ft to 100 ft deep, and will carry equipment for drilling to 15,000 ft. A 140-ft drilling mast on two-way sliding equipment on the main deck will enable a cluster of wells to be drilled without moving the platform.

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World Exploration Hits Peak

(Continued from page 41)

On land, the outstanding exploration developments were the discovery of the Khurais well by Aramco, which indicated a probable new field, and the discovery of oil in Dhofar province of Muscat and Oman.

DHOFAR: Exploration by Cities Service has resulted in four producing wells to date, and one dry hole. The first well at Wadi Dauka went 11,767 ft—with no shows reported. Subsequently, four more wells were drilled and two are currently drilling. One of these, Northwest Marmul, was below 10,000 ft at the end of 1957. Marmul No. 3 was below 6,000 ft at the end of 1957. Marmul No. 1 and No. 2 found 80 ft to 190 ft of Cretaceous pay. The Marmul wells are currently making about 2,500 b/d. A survey has been undertaken for an offshore loading line.

In the remainder of Muscat and Oman, the Jebel Fahud well, located at longitude 56 deg, 30 min east, latitude 22 north, was drilled by Petroleum Development (Oman) Ltd., subsidiary of Iraq Petroleum, and abandoned at 12,235 ft in June 1957. Oil shows were encountered in many spots in this well, but permeability was very low. The company has moved off, and will drill farther from the mountains.

EGYPT: Sahara Petroleum Co.—owned by Continental Oil Co., The Ohio Oil Co., Cities Service Co., and Richfield Oil Corp.—continued its exploration at a diminished rate during 1957—with no discoveries made. The company retired from Egypt during the Suez crisis, and re-entered early in 1957; but it is now running only one rig.

By Law 135 of 1956, later amended by Law 332 of 1956, the General Petroleum Authority was formed to manage the government's oil interests. In 1957, the 63 exploration areas which previously had been granted to Shell and Socony Vacuum were granted to the General Petroleum Authority.

During 1957, the government announced a discovery by Eastern Petroleum Co., at Abu Rodeis, on the Sinai coast. The well flowed 120 bbl per hour, on initial test, from 8,373 ft to 8,840 ft. First discovery in this area was No. 1 Abu Rodeis, 240 ft away. Location is on the west coast of Sinai, across the Gulf of Suez from Ras Gharib field. Eastern Petroleum took over International Egyptian Co.'s Belayim and Feiran fields on Sinai. Petrofina and the Italian government's AGIP have an interest in International Egyptian.

IRAN: SIRIP, jointly owned by AGIP Mineraria (owned, in turn, by the Italian government through ENI), and National Iranian Oil Co. (NIOC), received a concession widely publicized as an upset of the traditional 50-50 profit-sharing arrangement in the Middle East and other parts of the world, but it actually was not.

The consortium resumed active exploration in 1956—with a survey party in the area between Bandar Lingeh and Bandar Abbas. Studies were made of the anticlines near Bandar Lingen and the large Kuh-i-Bandi-Lingeh rock formation. Two seismic parties worked north of Bushire near Ganaweh and, at the beginning of 1957, were on structures at Bibi Hakimeh and Kuh-i-Binak. In the second quarter of 1957 six crew-months were put in, using two lease crews from Geophysical Surveys Inc.

A wildcat is to be drilled in the Kuh-i-Binak structure, which is on the Persian Gulf close to the offshore block belonging to SIRIP. It is the first wildcat on the coast of Iran in 25 years.

During late 1957, the government divided Iran into some 20 to 25 petroleum "zones," and announced that about two-thirds would be opened to bids. The Qum area is reserved to government development only.

IRAQ: Iraq Petroleum Co. Ltd. drilled about 21,900 ft in 1957. (Estimated completions: six wells, of which three are producers.)

Basrah Petroleum Co. Ltd. maintained a two-string drilling program. Rachi No. 1 was completed and abandoned at 12,959 ft in April. Suhain No. 1 was spudded in, October 22, and had reached 4,060 ft by the end of November. Total footage for the year will be approximately 61,200 ft. (Estimated completions: six wells, of which four are producers.)

Mosul Petroleum Co. Ltd.—Tharthar No. 1 was abandoned at 12,610 ft in August. In February, Gullar No. 1 was abandoned at 10,148 ft. Ibrahim No. 1 had reached 10,776 ft and was about to be abandoned in November. Falluja No. 1 was spudded in on August 24, at the end of November its depth was 7,994 ft. Two wells were drilling at Butmah in November. Total footage for the year will be approximately 24,200 ft. (Estimated completions: four wells, of which one is a producer.)

ISRAEL: During 1957 a discovery was made at Brur 2, about one mile south of Heletz field. This was the second discovery of oil in Israel; the first was at Heletz during September 1955. On 24-hour test, Brur flowed 280 bbl on ⅛-in. choke. It found 15 ft of pay sand just below 5,000 ft, equivalent to the Nubian sandstone which produces at Heletz.

Current interest is being shown in the deep test being drilled near Sodom, in the Jordan valley, by Lapidoth Israel Petroleum Co. Ltd. and Israel Oil Prospector Corp. Ltd.—now drilling below 8,000 ft in stratified salt beds. Considerable difficulty has been encountered in penetration of the salt bed, and fishing jobs are frequent.

Judean Petroleum Co. is drilling below 2,500 ft on a deep test on the Judean anticline near Jerusalem.

On the coastal plain, Lapidoth Israel Petroleum Co. Ltd. and Israel Oil Prospectors Corp. Ltd. are drilling a Jurassic test in the Heletz oil field. This well, designated as Heletz 22, is situated on the east side of the structure. It is drilling below 6,000 ft, beneath the principal oil-producing horizons which occur in two sandstones in the base of the Upper Cretaceous system.

KUWAIT: Work carried out during the year included drilling to determine the northern limits of the Raudhatain structure and a wildcat to investigate the Mutriba structure. Because of lost-circulation difficulties and a protracted fishing job, progress on the Mutriba well has been slow, and no significant results have been obtained. During the year, one seismic-reflection party continued with the reconnaissance coverage of the State. Additionally, an underwater survey was made of Kuwait Bay by the M.V. "Sonic."

NEUTRAL ZONE: During 1957, no geological or geophysical exploration was carried on by American

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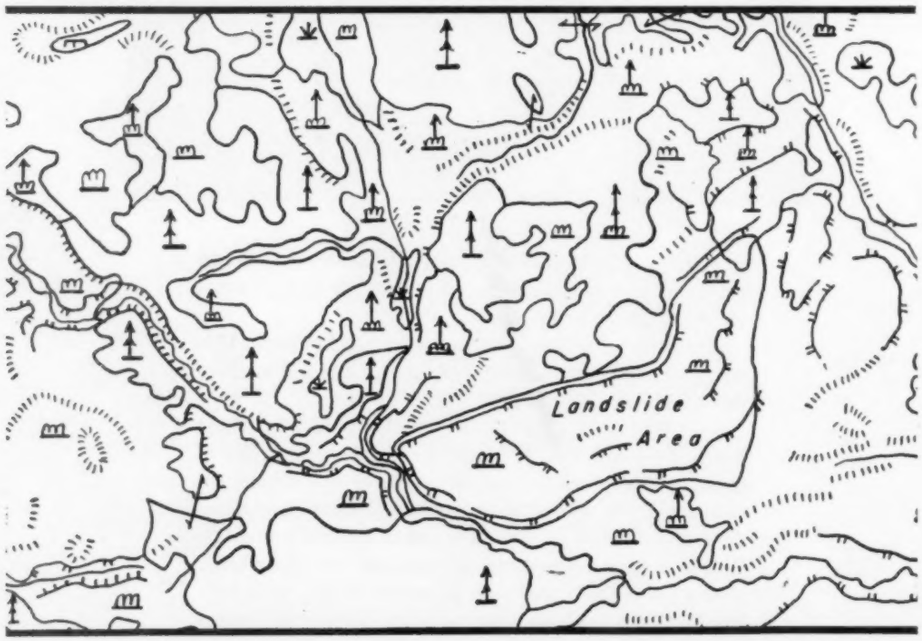

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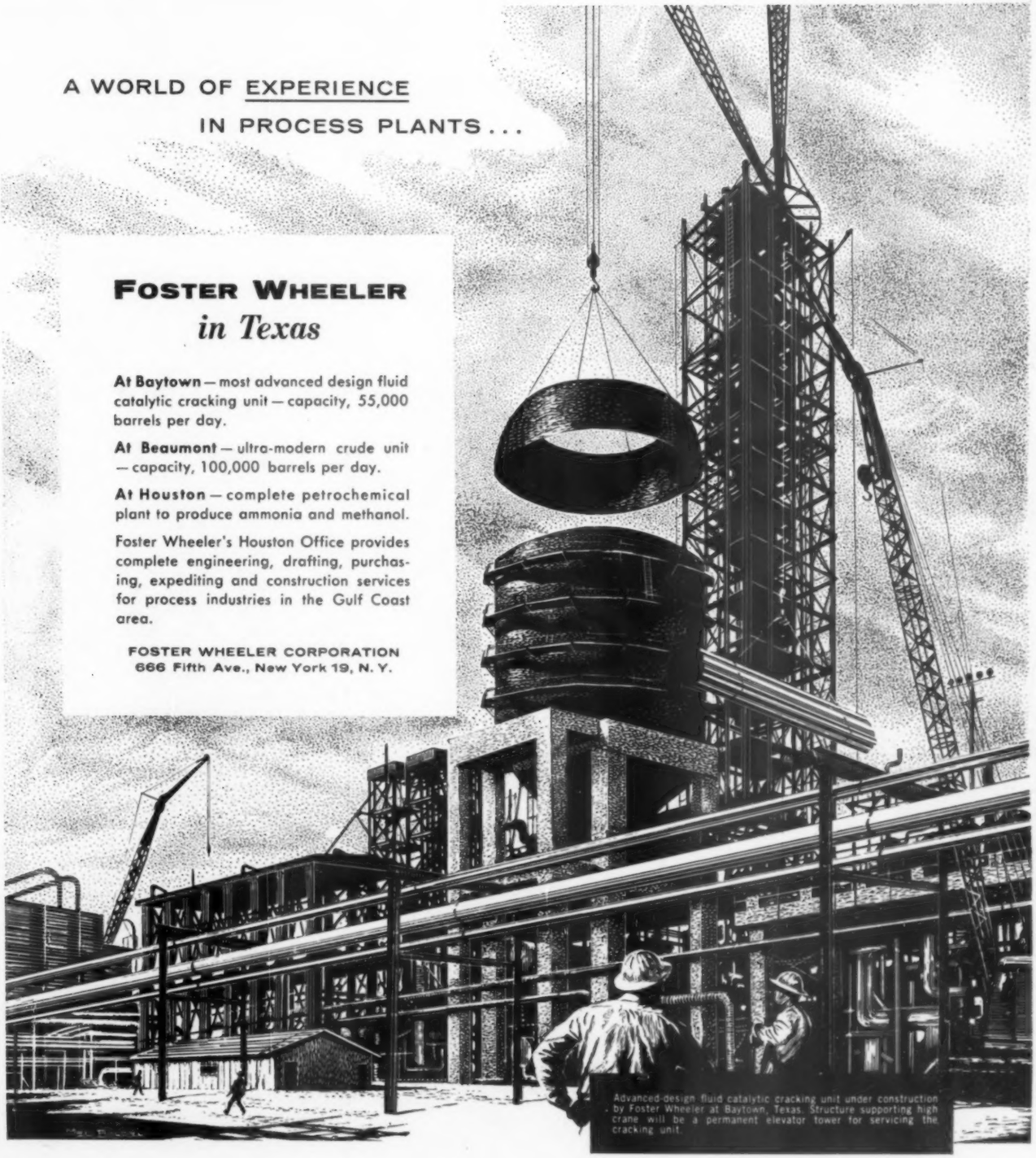

Advanced-design fluid catalytic cracking unit under construction by Foster Wheeler at Baytown, Texas. Structure supporting high crane will be a permanent elevator tower for servicing the cracking unit.

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Independent Oil Co. or Getty Oil Co. in the Kuwait-Saudi Arabia Neutral Zone. Drilling was confined to development wells in the Eocene, Burgan, and Ratawi zones. The number of wells drilled in each of the zones was: 47 Eocene, average depth 1,200 ft; 4 Burgan, average depth 3,600 ft; 6 Ratawi, average depth 7,000 ft.

SAUDI ARABIA: Outstanding development in exploration during 1957 was discovery of oil in a wildcat well 90 miles northeast of Riyadh. The well, known as Khurais No. 1, is the first to be drilled on the Khurais structure, which is the Dahana—a belt of sand dunes east of the central plateau. The structure was located by gravity-meter and structure-drill surveys. Drill-stem tests of the Arab "D" member of the Arab zone between 4,755 ft and 4,898 ft indicated production rates up to 3,000 b/d. Gravity is 31 API at 60 F, and the oil is sour.

Khursaniyah No. 2, the first delineation well drilled since the discovery of the Khursaniyah field in 1956, located four miles north-northeast of the discovery well, was drilled to a total depth of 7,885 ft. It defined the northern limit of the field. Khursaniyah well No. 3 has been spudded three miles south-southeast of the discovery well.

An exploratory well, 12 miles north-northwest of the northernmost well in the 140-mile-long Ghawar field, was drilled to a total depth of 7,325 ft and completed at a depth of 7,120 ft for potential production from the "D" member of the Arab zone.

In December 1957, Aramco announced discovery of a second offshore oil field. In a drill-stem test, oil was found in Manifa No. 1, located in the Persian Gulf about eight miles off the coast of Saudi Arabia and 120 miles northwest of Dhahran, Aramco's headquarters. The Manifa discovery was made in an interval tentatively identified as the Arab "A" member of the Arab zone.

During 1957, several new companies were interested in oil rights offshore and onshore. They included Atlantic Refining Co., Conorada Petroleum Corp., Indiana Standard, and a Japanese company, Arabian Oil Co. Ltd. The latter company received a concession during early December over the Saudi Arab part of the Kuwait-Saudi Arab Neutral Zone offshore rights.

SYRIA: Syria's first oil discovery was made during 1956, at Karatchok, by James Menhall Drilling Co. A second test during 1957, about 1½ miles from the discovery, found oil at 5,870 ft. A third test is now drilling nearby, and a fourth is being spudded. A total of 12 wells is planned by the end of 1958. The Atlantic Refining Co. holds a 50% interest in the concession, and Portsmouth Steel Corp. also holds an interest. A German company, Deutsche Erdoel AG, is now below 4,700 ft, and reported shows at its first wildcat location in the Ghouna area of Jezira province, near Turkey. A second well is planned for early 1958.

Under an economic agreement signed with Russia, October 28, 1957, a concession for exploration over 50,000 square kilometers was received by Russia. A technical survey map of the area will be made, on a scale of 1:200,000—with 2,000 linear kilometers of seismic prospecting work, and drilling of 18 wells in the northeast of Syria up to a total depth of 36,000 meters. Equipment and material also will be provided by the Russians.

TURKEY: Tidewater-Atlantic-Seaboard group spudded its first exploratory well at the top of Mount Bakuk in southeastern Turkey, about 40 miles southeast of Mardin, or around 30 miles northeast of Nusaybin. American Overseas Petroleum Ltd. spudded in its second well in Turkey, at Kahta Cayi structure, 17 miles southeast of the provincial capital of Adiyaman. In the Gaziantep area, 70 miles northeast of the first Amoseas well in Turkey, Aril No. 1, abandoned at 10,153 ft.

A farmout by Gilliland Oil Co., a Los Angeles independent, is held by Turkish-American Oil Co. The first well was temporarily suspended at 7,900 ft, near Cizre, close to the Iraq-Syria border. No shows were encountered. The well will be resumed next spring.

Marmara Petroleum Corp. has completed a gravity survey of its four licenses in Petroleum District No. 1, in Thrace—using Seismos Exploration Co., of Hanover, Germany. No plans for exploration drilling have been made, nor will any be made until after the seismic work has been completed.

Bolsa Chica plans to begin drilling in Zone 5V. Date for this well has not yet been set.

Deutsche Erdoel AG, a German company, will drill its first well soon. The company drilled a test, No. 1 El Bouav, in northeastern Syria during 1957.

Istanbul Tabii, partly owned by Ralph M. Parsons Co., has not drilled any wells so far, but has done geophysical work and some geological structure drilling. The company has no plans for immediate drilling.

Standard Oil (Turkey) Inc., a Jersey Standard affiliate, spudded its first test in Thrace at Celan 1, April 15, 1957. It was abandoned dry at 4,350 ft about June 1. The rig was moved to Ozmancik, about 5 miles west, and is presently drilling there.

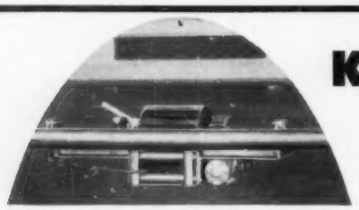
1957 was marked by considerable increases in exploration throughout Europe, but no sizable discoveries. In Belgium no exploration is known to have been performed in 1957; however, a new company for oil exploration was formed, Ste. Bèlge de Réchèrches et de'Exploitation Pétrolières (Pétrobèlge).

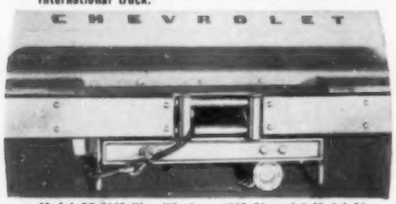
In Denmark, Jersey Standard has purchased Gulf Oil Corp.'s company, DAPCO, and has two seismic crews working. Gulf drilled six dry holes in Denmark before giving up the concession. DAPCO began drilling for oil in December 1957 in Jutland, under contract with Kellogg Overseas Drilling Co. of California. Esso's budget for oil exploration this year is ten million kroner, and the same amount for next year. Company considers the two best possibilities are at Harup in Thy and at Vem, two villages in the northwest—one on each side of Nissum Bredning.

In Greece, two wells were drilled—both dry. Deilmann Bergbau GmbH, a German independent company, drilled a well, Edros 1, two miles southeast of Ardanion No. 1—without success. On the island of Dante, two American companies, Israel Mediterranean Petroleum Inc. and Pan-Israel Oil Co. Inc., acquired a 120,000-acre concession. No oil was found, and the companies gave up the concession after drilling a total of 7,000 ft.

No exploration was performed in Eire (Ireland), Finland, Norway, or Sweden during 1957.

In Switzerland, legal difficulties continued to impede exploration. The most active company was


Model A-11 King Winch on A-120 (4x4) all-wheel-drive International truck.*



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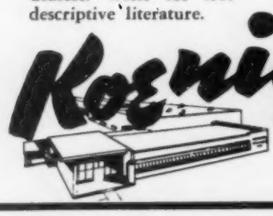

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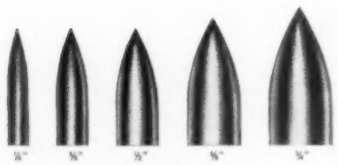

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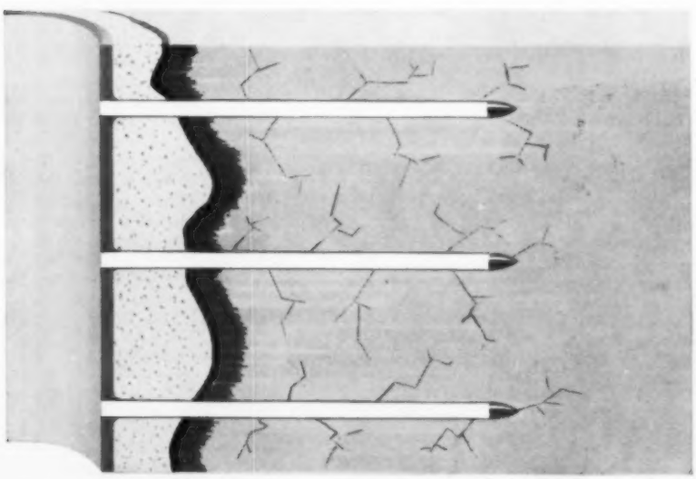

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Europe

SEAG, registered during November 1956 for oil and gas exploration. The German company of Elwerath is doing exploration, and reportedly surface work has begun in the vicinity of Lake Zürich. $300,000 was budgeted in mid-1957 for seismic work. A number of the major companies are known to be interested in the area, but the requirement of 75% Swiss capital has discouraged operation.

AUSTRIA: No major discoveries were reported in 1957.

Austrian Mineral Oil Administration (OeMVAG) and British Petroleum Co. recently reached agreement in London on joint (50-50) prospecting and exploitation of oil in the areas of Scheibbs and Amstetten (Lower Austria province). Agreement provides for a working group, with £100,000 from each partner during the first year.

FRANCE: The most notable development was discovery of the first productive sandstone in France—all previous production having been from limestone. The find was near Dax, in southwest France, by Ste. Nationale des Pétroles d'Aquitaine (SNPA), at Clermont 2.

A 75-min drill-stem test of a 105-ft Upper Cretaceous sandstone interval between 6,260 ft and 6,365 ft produced 9 bbl of 35 API gravity crude, 5 bbl of water, and a show of gas from the impregnated sandstone. Clermont 1 was bottomed at 11,080 ft as a dry hole after having encountered several noncommercial shows.

Mobil Repga took up permits on most of the acreage around Bordeaux—given up by Esso—of nearly 2,200,000 acres, or half of Esso's initial concession. The rest of Esso's former acreage was awarded to two local companies, Cie. d'Exploration Pétrolière (CEP), and Régie Antonome des Pétroles (RAP).

Concessions held by the State-controlled Ste. Nationale des Pétroles d'Aquitaine (SPA) were given up in October. SPA retains only 30% of the concessions, including the Lacq oil-and-gas deposit area. The remainder was shared equally among eight companies—three of them foreign.

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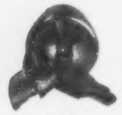
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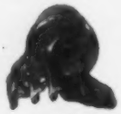
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ITALY: Southeast Sicily is the center of activity (although the entire island is a sedimentary basin). At Gela, on the south coast, AGIP discovered a field whose oil is heavy—its gravity 6 API—with a high sulfur content. Net production at Gela No. 1 is about 1,200 b/d from the Dolomite. AGIP is now drilling three additional wells at Gela, and is ordering two new rigs to step up development.

East of Ragusa, at Rosolini, AGIP has a Dolomite well capable of producing up to 1,500 b/d of 15-gravity oil from a thin 58-ft section. This well may be on the flank of an important structure.

West of Ragusa, at Vittoria, British Petroleum Co.'s Italian subsidiary CISDA has found 9 API gravity oil in the same formation. The company has completion difficulties at the location, but is planning a commercial production test.

NETHERLANDS: Exploration in the Netherlands has continued actively, pushed by the NB Nederlandse Aardolie Maatschappij, owned 50% by Standard Oil Co. (N.J.) and 50% by Royal Dutch-Shell group. Most recent discoveries have been in Ijsselmonde, Ridderkerk, Zoetemeer, Moerkapelle. The Ijsselmonde discovery was on the south bank of the Maas River in western Holland. The discovery well was initially producing about 63 b/d of 18.4 API crude from the Upper Barremian sandstone, which is part of the lower Cretaceous, at 3,100 ft. During 1957, this area was extended to 655,000 acres, when NAM's application was granted during April.

Two seismic crews have been operating for NAM—mostly on the mainland, but with one crew carrying out a survey of a possible extension of the western Holland productive trend to the North Sea.

PORTUGAL: Exploration is being conducted by Cia. dos Petroleos de Portugal (CPP), with Mobil Exploration Co. of Portugal Inc., a subsidiary of Socony Mobil Oil Co., supervising the geological studies and drilling under a contract signed February 15, 1955. Casa Prakla, a German company, is doing seismic exploration for CPP on about 350,000 acres, using two crews.

SPAIN: Three companies have continued active: CAMPSA (the government's marketing company); CIEPSA, associated with C. Deilmann Bergbau, German independent; and Valdebro, a combination of USA private interests and Spanish government interests. A detailed report on recent work appears elsewhere in this issue.

UNITED KINGDOM: During 1957, seismic and gravity surveys were conducted in several new onshore areas. Eight wildcats were completed without tangible results, and two were drilling at the end of 1957. Six in the East Midlands resulted in five dry holes and one noncommercial gas well.

North Africa

North Africa has become one of the world's hottest exploration areas, with the discovery of oil in Algeria. By the end of 1957, the French had spent more than $127 million looking for oil in the Sahara Desert, almost $52 million of it in 1957. The French expect France and French overseas territories to fulfill all French oil needs by 1972, with the largest contributor to be the Sahara—where Edjélé will contribute 80,000 b/d, and Hassi Messaoud 100,000 b/d.

Late in 1957, the Bureau de Réchèrches de Pétroles, owned by the French government, stated that foreign participation would be favored in oil exploration in the Sahara if held to a minor interest, and if it supplied its own equipment and technicians. It also specified that French interests must receive at least reciprocal treatment in exploring companies.

During late 1957 Conorada Petroleum Corp.—owned by Amerada, Ohio Oil, and Continental Oil Companies—received an exploration concession covering 28,000 square kilometers in west-central Tunisia. Final approval on the concession has not yet been received; however, the company announced it expects to put two full teams of geologists into the field shortly. They will include photogeologic exploration in the region of Chott el Djerid. Conorada is obligated to spend 1.4 billion francs ($3.3 million) over the next five years on its concession.

The Ste. Nord Africain des Pétroles (SNAP), which had been held 65% by Gulf Oil Corp., gave up its search in 1954. At present only one company is operating in the country, SERPT (Ste. de Ré-

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chèrches et d'Exploitation de Pétroles en Tunisie). This company is owned 70% by the French government and 30% by the Tunisian government. The company has four rigs working, and has spent some $28 million during each of 1955 and 1956 on exploration. Oil shows have been obtained recently at Erg Lequine.

The three principal discoveries in Algeria are Hassi Messaoud, Edjélé, and Tiguentourine. Since French law requires that 50% of exploration acreage be surrendered after a certain period, considerable acreage in this area is now being surrendered, and applications have been made on the area by various countries. There is no doubt that discoveries in Algeria are of major importance. They are especially important to France because of their strategic location and the possibility of deriving oil from more dependable sources than the Middle East.

In Libya, the government is pushing exploratory development very rapidly, and a number of new wildcats are drilling.

The government of Somalia, a United Nations mandate in East Africa, has granted Standard-Vacuum Oil Co. a 10,300-square-mile concession in which the company plans to begin exploring early in 1958. The concession area forms a parallelogram about 50 miles wide which extends approximately 200 miles along the western side of Somalia, on the Ethiopian border.

Term of the prospecting permit under the Somalia mining law is three years, which may be extended three times for two-year periods. The law provides for a 40-year concession to produce any commercial oil deposits which may be discovered. At the government's option, a 10-year extension may be granted twice.

In Morocco, an exploration concession was reportedly obtained by Mayflower Properties Inc., in Texas; however, this was not confirmed by the government. During the year, a wildcat in western Morocco had a promising gas discovery 25 miles east of Mogador. The well was drilled by Ste. Chérifiènne des Pétroles. Present oil and gas production is located about 280 miles north of Mogador.

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Production is declining slightly, and no discoveries have been made in recent years of importance.

Central and South Africa

NIGERIA: Shell-BP has drilled seven wells at Oloibiri, and five at Afam—with two dry at Afam and three at Oloibiri. Drilling is continuing in both places. Shell-BP reported that No. 4 Oloibiri was abandoned as a dry hole at 10,500 ft, and the well plugged and abandoned. This failure seems to prove the southern limit of the field, and drilling is now being transferred to the eastern part of the structure, about two miles to the east of Oloibiri No. 3. There were four producers at end of 1957.

Oil was struck in Afam No. 3 well during mid-1957, about 20 miles east of Port Harcourt. No. 3 is located about ¾ miles south of Afam No. 1, which struck oil at the end of 1956. No. 2 and No. 4 were dry. Shell-BP now plans to drill more wells, about two miles west, to determine the extent and capacity of this potential field. Afam No. 5 was a producer during December 1957. A 6-in. pipeline is being laid to Port Harcourt.

At Benin City area of western Nigeria a heavy rig is being moved in, 16 miles south. Shell-BP abandoned its last well in the region three years ago after a noncommercial show at 6,387 ft. A fifth rig was received by the company during 1957. It resumed drilling on No. 2 Ituk in eastern Nigeria, which was shut down during 1956 due to mechanical troubles.

Shell-BP ordered its first drilling barge during 1957. The $3.6 million unit will operate in tidal swamps in the Niger delta. These extend from 30 to 40 miles from the coast, and are flooded to a depth of 4 ft or more at high tide.

Two American companies—including Socony Mobil and Jersey Standard—have shown interest in the area. Socony Mobil has an application covering about 4,000 square miles, which is practically identical with another application by Jersey Standard. Award of the concession has not yet been made.

In Tanganyika, BP-Shell Petroleum Development Co. of Tanganyika is drilling its third deep test well at Mandawa, about 15 miles inland and located midway between Kilwa and Lindi on the southern coast of Tanganyika. The company had previously drilled two wells; both of them dry. One on Mafia Island was taken to 11,051 ft. The other, on Zanzibar, was carried to 14,281 ft. Company currently is running other exploratory parties in Tanganyika, but no decision has been made to drill another well in Zanzibar.

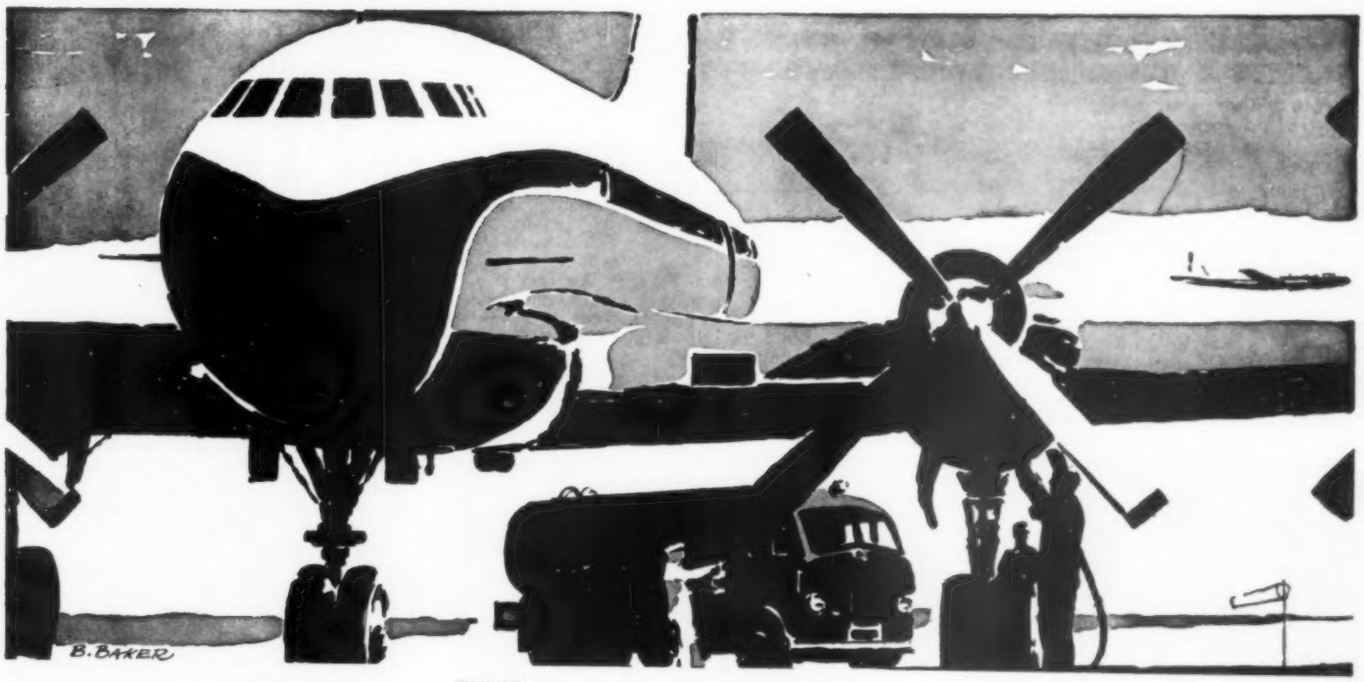
The recent discovery of oil in the Gabon is the final stage in a campaign of exploration by Ste. des Pétroles de l'Afrique Equatoriale Française (SPAEF), owned 58.8% by the French government's BRP. So far, three minor pools have been found at Pointe Clairette, Ozouri, and Port Gentil. Production is expected to rise to about 10,000 b/d in 1958. Discovery was made in July 1955 in an interval from 4,174 ft to 4,207 ft. As of mid-1957, eight producing wells and four dry holes had been completed. Average per well production is 63 b/d. Crude is heavy and high in asphalt, similar to Lagunillas crude in Venezuela. Recently the company found new shows at Animba and Am'Bega.

SPAEF began drilling in the middle Congo during 1957, and the first wildcat was a discovery, 300 miles southeast of the company's producing fields in the Gabon. The wildcat, No. 1 PI, was drilled at Pointe Indiènne. It found oil-bearing sandstone at 4,442 ft. As of December 1957, six wells had been drilled on it. NB 3, 4, 5, and 6 gave about 42 bbl per hour from the 2,844-ft to 2,920-ft. interval in the Eocene. One well, MB-5, flowed 15½ bbl per hour from 2,763 ft to 2,796 ft in the Eocene.

In the Gabon, a new test, PG-7, flowed 56 bbl per hour from 5,036 ft to 5,101 ft in Aozouri field. A second offshore well, OZM-2, is to be drilled ½ mile northwest of the first productive offshore well, OZM-1.

Cameroun: Three gas wells brought in at Logbaba during 1956 proved disappointing for Ste. de Réchèrches at d'Exploitation des Pétroles du Cameroun. The company revised its estimates to a reserve of only 7.7 billion cubic feet.

Gulf Oil Corp. is drilling its fourth well in Ghana. The company has spent about $1.5 million since June 1956. The fourth well is in western Nzima district. Three previous wells were dry.



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Exploration in French West Africa is being conducted by Ste. Française des Pétroles BP. The company drilled a well in Senegal early in February, which went to 6,560 ft—with no shows. The current test is 14 miles northwest of M'Bour.

On the Ivory Coast, Plymouth Oil Co. is negotiating for a half-interest in a 3,700-square-mile permit recently granted to the Ste. Africaine des Pétroles, owned 80% by the French government. The company currently is planning to drill near Dakar. A well at M'Bourouk, some 35 miles east of Dakar, was dry, and abandoned at 13,153 ft. Two wells by SAP were abandoned at 2,132 ft without encountering the Cretaceous. The second was abandoned in the Cretaceous at 3,379 ft—with no shows.

In the Union of South Africa, several new concessions have been granted. D. J. Harris, of Walvis Bay, Union of South Africa, has been granted a concession, extending from 20 miles south of Walvis Bay to the southern boundary of Swakopmund—including the coastal strip, except for municipal boundaries of the two towns. Five other applications for concessions are being considered.

The Harris concession is understood to be for 12 months. One provision is that prospecting must start in six months; another that £40,000 ($112,000) to £50,000 ($140,000) must be spent in South West Africa in the 12 months.

Interests representing A. S. Onassis, the shipping owner, are reported core drilling on a concession in South West Africa. Republic Oil Co. is among those granted concessions, according to the *Official Gazette*. Another concessionaire is the firm of K. P. Albrecht & Co., a German financial interest representing Deutsche Erdoel AG, a German concern, and the Belgian company, Cie. Financière Bèlge des Pétroles (Petrofina), which made a recent discovery in Angola. It is reported that German geologists employed by Albrecht have made extensive surveys in the Stampriet area of South West Africa during the past three years, and that Albrecht has a considerable quantity of exploratory equipment in Angola and Germany awaiting shipment to South West Africa.

Interests in Los Angeles, Calif., are associated with and represent concessionaires holding oil and gas rights to approximately eight million (8,000,000) acres in South West Africa—including large areas on the coast as well as in the interior in the Stampriet-Mariental area.

Far East

AUSTRALIA: No discoveries have been made in Australia despite a very active exploration campaign. About $78 million had been expended to mid-1957. WAPET (Western Australian Petroleum Pty. Ltd.), owned 80% by Caltex and 20% by Ampol, a local company, has spent about $29 million, and recently announced wells will only be undertaken after extensive preliminary work in the future.

Location for an exploratory well in the Canning basin has now been selected at Samphire Marsh, about 30 miles southwest of Anna Plains homestead. The well will be drilled to a depth of about 8,000 ft to 10,000 ft—the deepest test so far planned in the Canning basin. It may be the first in Western Australia to qualify for the commonwealth government's newly enacted drilling subsidy.

South Pacific Pty. Ltd. has been formed, with Australian and American participating capital, to drill on a 7,000-square-mile concession near Tambo, Queensland. The company will drill one or perhaps two wells in the Tambo area.

In order to encourage the search for oil, the government has announced it will meet part of the cost of deep stratigraphic drilling—a maximum of half the cost of each hole drilled at approved sites.

Santos Ltd. has obtained shows of oil, and has encouraging prospects in South Australia and Queensland. Delhi Taylor Oil Corp., controlled by Clint Murchinson, is now sending geologists to look over Santos' acreage.

BURMA: BOC was spudding in, December 6, a wildcat well at Ondwe, in the Magwe district of central Burma. The Ondwe structure is a well developed dome on the same axis of uplift as Yenangyaung field about 30 miles northwest. Another deep test is to be drilled during 1958 in the Irrawaddy delta.

INDIA: Standard Vacuum well, Burdwan No. 1 in West Bengal, about 30 miles northwest of Calcutta, was abandoned dry—with no shows—at 8,921 ft. The company spudded a second well, Galsi 1, about 35 miles northwest of Burdwan. It was abandoned at 4,250 ft late in 1957; and a third well, Jalanzi 1, was begun.

The government, with the help of three Russian and Romanian rigs, spudded an exploratory well in the Kangra valley of the Jwalamukhi area in the Punjab, about April 1957. Oil shows were reported during November. Nine locations have been staked out in the Kangra valley—three in Jwalamukhi area and one each in Janauri, Dharamsala, Yol, Nana, Nurpur, and Bhal. Other wells are planned at Cambay, in Bombay, and in the Sigsagar area of Assam, according to press-correspondent reports.

INDONESIA: Standard-Vacuum Oil Co. suspended oil exploration in Sumatra during November 1957 because of its inability to obtain permission from the Indonesian government to explore and develop new concession areas. The company's last geophysical party in Sumatra completed its mission in October. In December 1957, however, the government announced the company's exploration applications were being "considered."

Since World War II ended and the Japanese were forced out of Indonesia, the "big three" operating oil companies—Sarawak Oil Fields, Standard-Vacuum Oil Co., and Caltex—have tried unsuccessfully to persuade the government to grant new oil concessions.

On June 18, 1957, New British Dominion Oil Co. Ltd., Calgary, Alberta, acquired 49% of the stock of Nusantara Mining Corp., through Sea Oil & General Corp., of New York. Nusantara has exploration licenses in the Palembang block, Sumatra, expiring April 3, 1959, and applications pending for 720,000 acres. The Palembang block is located in the southeastern part of Sumatra, and that part northwest of the Ogan River is straddled by the producing fields of BPM.

Most of the licenses were granted in 1956—with three-year duration, and renewable for two additional one-year periods. All are conditional on exploration work being done thereon.

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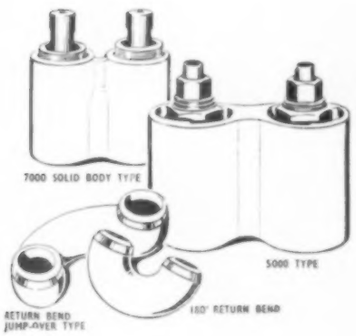

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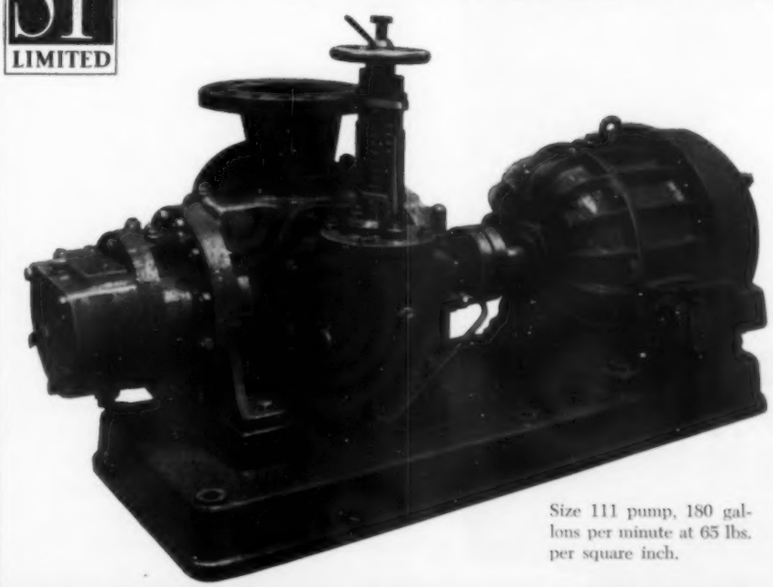

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JAPAN: Despite an active exploration campaign designed to offset declining production levels, only one significant discovery was reported during 1957. It was by the Petroleum Resources Development Co. in Niigata prefecture, 600 miles northeast of Tokyo, at 4,950 ft at Oguchi, Nakanoshima village, 3¾ miles north of Nagaoka. The new find is believed bigger than the company's oil field at Yabase in Akita prefecture, which at present is the nation's largest field. Production was about 150 b/d. The structure is about 5 miles long, by ¼ mile wide.

BRITISH BORNEO: Coordinated exploration is carried out in the three territories (and adjoining marine areas) of Sarawak, Brunei, and North Borneo by the three Shell-group associated companies: Sarawak Oilfields Ltd., Brunei Shell Petroleum Co. Ltd. (which took over the assets of British Malayan Petroleum Co. Ltd., early in 1957), and Shell Co. of North Borneo Ltd.

During 1957, the only exploratory drilling was from two marine platforms, where hopes had been high for new oil-bearing structures; but no oil was found.

From one of these platforms, situated some 21 miles offshore from Seria oil field, Brunei, drillers unexpectedly met with troublesome 'heaving shales' at 1,300 ft, and this information continued down to at least 5,980 ft, when it was decided to plug and abandon the well. The location was described locally as Ampa Patches.

This was the first time 'heaving shales' had been encountered in the British Borneo territories. Difficulties had also been experienced in the strata above this plastic formation. The coral reef and loose sand formation were extremely porous, and much of the drilling mud was lost into the formation, and the loose sand tended to fill up the hole. The platform at Ampa Patches has now been dismantled. The other platform, referred to locally as the Siwa location, was situated some eight miles direct from Miri oil field. Here, two wells were drilled, but both were dry. The first was drilled to 7,680 ft before being abandoned. The second, which was primarily drilled to obtain further geological information, was deviated to about 5,000 ft before being plugged and abandoned. As a result of these operations, the Siwa platform is also being dismantled.

Meanwhile, Shell Co. of North Borneo was erecting a similar marine platform some 30 miles north of the island of Labuan, at a location described as Hankin Shoal, and a first well is to be drilled there early in 1958.

The three companies have now decided, however, on the basis of the results so far, to hire a mobile drilling unit from De Long Corp. The unit will range over the China Sea, carrying out exploratory drilling at all prospective locations. If any oil is found, smaller production platforms will then be erected as the need arises. The erection of fixed platforms for exploratory purposes is not contemplated in future.

In Seria oil field, a special 'deep test' well was drilling towards the end of the year, to penetrate and test formations below the known oil and gas producing sands of the field.

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ROTARY DRILLING RIGS ACTIVE

Country	Number of Rigs Feb. 1, 1958	Feb. 1, 1957
Western Hemisphere		
Alaska	3	5
Argentina	67[1]	68
Bolivia	11	12
Brazil	54	29
British Honduras	2	0
Canada	227[2]	238
Chile	6	6
Costa Rica	2	1
Cuba	8[4]	9
Colombia	20	23
Ecuador	5	9
Haiti	0	1
Jamaica	0	1
Mexico	120[6]	95
Peru	7	21
Trinidad	29	27
United States	1,947	2,264
Uruguay	0	1
Venezuela	153	129
TOTAL WESTERN HEMISPHERE	2,661	2,939
Eastern Hemisphere		
Algeria	24[7]	18
Angola	2	2
Australia	9	3
Austria	32	15
Bahrain	1	3
British Borneo	7	8
British Isles	3	8
Burma	6	6
Denmark	1	0
Egypt	3	2
Ethiopia	0	1
France	20	28
French Equatorial Africa	8	8
French Morocco	5	6
Germany (West)	120	105
Greece	1	1
India	7	8
Indonesia	20	23
Iran	10	10
Iraq	6	10
Israel	6	12
Italian Somaliland	1	1
Italy & Sicily	35	38
Japan	15	15
Jordan	2	0
Kuwait	7	6
Lebanon	0	0
Libya	8	2
Madagascar	1	2
Netherlands	5	4
Neutral Zone	6	6
New Guinea	4	3
Nigeria	5	6
Pakistan	7	10
Papua	4	3
Portugal	2	3
Qatar	2	4
Saudi Arabia	5	5
Spain	3	3
Syria	2	1
Trucial Coast	1	1
Tunisia	3	2
Turkey	8	7
Yugoslavia	26 est.	26 est.
Zanzibar	1	1
TOTAL EASTERN HEMISPHERE	479	464
WORLD TOTAL	3,140	3,403

(1) As of Jan. 1, 1958
(2) As of Feb. 3, 1958
(4) As of Jan. 15, 1958
(5) As of approx. end of 1957
(6) As of Jan. 28, 1958, Includes 41 workover & service rigs operating
(7) As of Jan. 15, 1958

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Canadian Notes

Canadian Mergers Effected

Merger of Merrill Petroleums Ltd. and Pacific Petroleums Ltd., Canadian independents, has been completed with approval by Merrill shareholders on the basis of two shares of Merrill for one of Pacific. Clifford R. Walker, president of Merrill, has accepted a post with Pacific as a member of the board of directors.

Merger represents one of the largest oil deals ever negotiated in western Canada—involving some $200 million in holdings.

Humber Oils Ltd. and Klintar Oils Ltd. have completed negotiations, subject to shareholders approval, for Humber to acquire all assets and undertakings of Klintar Oils for 687,000 shares of Humber on basis of two shares of Humber for one each of Klintar. Acquisition should mean company will have oil reserves of about 2,300,000 bbl and working capital of about $1,500,000.

It is expected Dr. A. W. Nauss, formerly of Link and Nauss, consultants, and former president of Scurry Oils Ltd., will become president and director of Humber Oils. L. G. Ruth, Toronto, president of Banff Oils Ltd., and now president of Humber, will become board chairman.

Canadian Merger

Continental Mining Exploration Ltd. and Glacier Explorers Ltd. have agreed to a merger, subject to shareholder approval. Continental's holdings are mainly mining, while Glacier Explorers' chief interests concern oil and natural gas.

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Canada May Curb Oil Imports

Despite anti-retaliation policy voiced by government leaders, pressure is mounting from within ranks of the Conservative Party for some form of retaliation aimed at forcing the USA to give Canadian crude a special break in USA markets.

Tariffs on USA crude have been unofficially suggested, as well as voluntary cuts in imports of foreign crude in areas which could be served by domestic crude.

In Commons, Finance Minister Donald Fleming stated: "We do not like to think in terms of retaliation at all, but the government was believed to be drafting a formal note of protest to the U. S. and expressions of 'great regret' in Canada over the U. S. decision for a 15% cut in crude oil imports west of the Rockies in District Five already have been voiced by the Canadian Finance Minister."

A 15-member group of Canadian independents has received a report on economics on placing western crude in the Montreal area now served by tanker-borne foreign crude. This marketing survey was prepared for the group by Walter Levy, New York consultant. The report has directed attention to capturing the eastern market. But import and price cuts undoubtedly would enter the picture.

Alaska-Yukon Products Line Approved

Plans by Alaska-Yukon Pipelines Ltd., Edmonton, to build a 160-mile products line from Haines, Alaska, to Haines Junction, Y. T., have received legislative approval in a bill passed by the senate, which restricts company's transports to oil and oil products only, with gas excluded. Forty miles of the proposed line—estimated to cost about $3,500,000—would run through Alaska, 18 in northern British Columbia, and the rest in the Yukon. The line would range in size from 4½-in. to 6⅝-in.

1958 Pipeline Meeting

The Pipe Line Contractors' Assn. of Canada will hold its fourth annual convention in 1958 in Victoria, according to president R. K. ('Ron') Banister. A. O. Ackroyd, executive secretary, expects this convention to be the largest ever held by the Canadian pipeline construction industry.

B-A to Spend $147 Million in 1958

British American Oil Co. will spend approximately $147 million in 1958 for exploration and development of oil and gas properties and the expansion of refinery, marketing, and transportation facilities. Exploration and production activities include $20 million for gas-utilization projects in western Canada.

Manufacturing additions also take a large portion of this program, including the completion late in 1958 of a new 20,000 b/d refinery at Port Moody, near Vancouver. At B-A's Clarkson, Ontario, refinery a new catalytic desulfurization unit and an alkylate unit are scheduled to be built. 1958 will also see a new catalytic reformer added at the Moose Jaw refinery. The balance of the 1958 program will be used for expansion of marketing and transportation facilities.

Vancouver Refinery Expansion

Imperial Oil Ltd. is going ahead with substantial expansion of its Vancouver refinery from 24,800 to 32,100 b/d by next summer, to make it the fourth largest of its nine Canadian refineries. By end of 1958, when new B-A refinery is onstream, Vancouver will have 91,100 b/d capacity, enough for projected demand through 1961.

Canadian Companies Merge

Under an exchange offer of Canadian Export Gas Ltd., substantially all of the company's shares are being acquired by Canadian Prospect Ltd., Calgary —on the basis of 2½ shares of Canadian Prospect for each share of Canadian Export. Canadian Prospect earlier increased its capital stock from four million shares of a par value of 16⅔ cents to 12 million. Under a welding of management, the two companies now have officers in common.

J. L. Kenney

Named Store Manager

J. L. Kenney has been named manager of Mid-Continent Supply Co.'s store at Drayton Valley, Alberta. He was formerly assistant manager at Edmonton, his native city.

Interprovincial Expansion

The Interprovincial Pipe Line Co. plans a $10 million expansion program during 1958, which includes 82 miles of 24-in. loop lines in Alberta and Saskatchewan, new pump units and pump station.

Upon completion of new facilities, capacity of the system will be increased to about 275,000 b/d out of Edmonton, as compared with previous capacity of 217,000 b/d; to 379,000 b/d out of Cromer, Manitoba (previously 246,000 b/d); and to 261,000 b/d out of Superior, Wis. (previously 147,000 b/d) to the Ontario market.

A new remote-controlled electrically-driven pump station powered at 4,400 hp will be constructed at Bay City, Mich., as part of the Lakehead system. Lakehead Pipe Line Co. Inc. is a wholly-owned subsidiary of Interprovincial. An additional 2,040 hp diesel pumping unit also will be installed at each of the company's pump stations at Regina and Glenavon, Sask., as well as Cromer and Glenboro, Manitoba.

The company's looping program calls for four sections, each approximately 20 miles long, running eastward from the company's pump stations at Edmonton and Hardisty, Alta., and Kerrobert and Loreburn, Sask. The 1,931-mile crude oil line, which carries western Canadian crude to eastern markets, was extended during the past year from Sarnia, Ont., into the Toronto area.

Imperial Vice President

J. A. Cogan, a director of Imperial Oil Ltd., has been named a vice president. Mr. Coogan has had more than 25 years of experience in the oil business, mainly in the refining and long-range economic planning fields.

Johnson for Canadian Oils

Norman C. Johnson, well-known in the marketing field in the Edmonton district, has received appointment as district sales manager for southern Alberta, Canadian Oil Companies Ltd. His headquarters will be Calgary.

Shell Consolidation

Shell Oil Co. of Canada Ltd., Toronto, has acquired all of the Canadian exploration and production properties, as well as other Canadian assets formerly held by several different Shell companies.

"All of Shell's Canadian exploration and production, transportation, refining and marketing operations, including petrochemicals, thus become integrated and consolidated in a single Canadian company—Shell Oil Co. of Canada Ltd.," stated Shell vice president Paul L. Kartzke in announcing the acquisition.

UNICOR® keeps corrosion from eating a big hole in your profits

Talk about money down the drain! Look at the ways corrosion can lose you money:

1. Reduced flow capacity means less volume handled per day. Corrosion in your pipeline takes up money-making space, reduces C factor and output.
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4. Equipment replacements aren't cheap, either. When corrosion takes over tanks and pipelines, you're out-of-pocket for new ones.

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3. Unicor costs about $0.001 (one-tenth of a cent!) per barrel of product. One molecule of Unicor to one million molecules of product gives effective anti-corrosive action.

Stop corrosion and fouling. Save money and improve product quality. Specify UNICOR for any internal pipeline corrosion problems. If you'd like to evaluate UNICOR before you send an order, write for information and samples.

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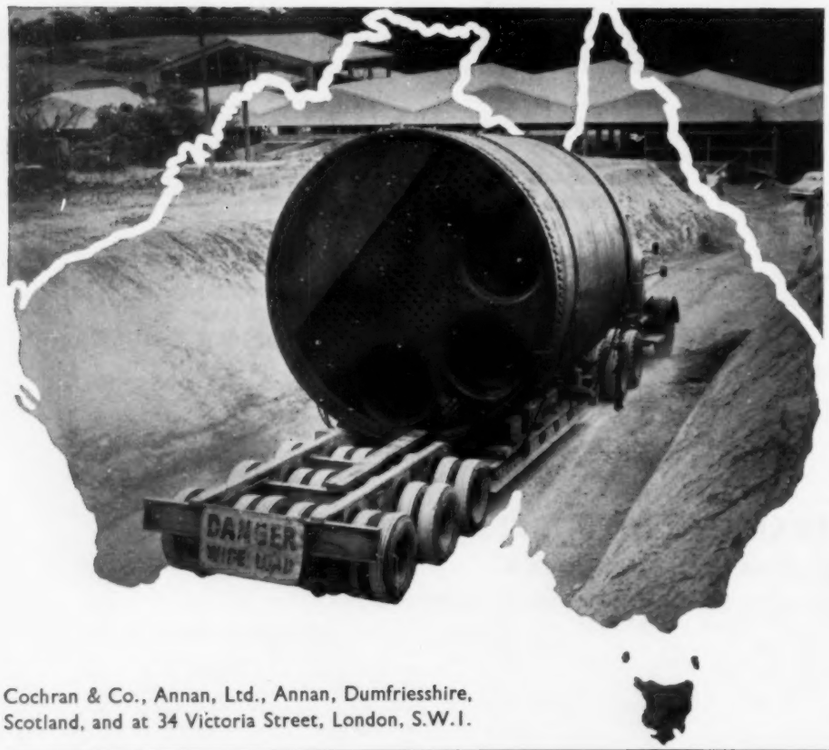
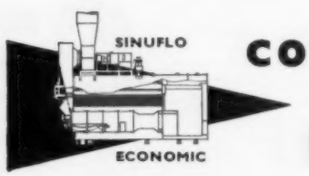
COCHRAN 'DOWN UNDER'



An 11′ 9″ diameter Cochran Sinuflo Economic boiler arriving at the factory of Thomas De La Rue (Aust.) Pty., Ltd., in Thornleigh, New South Wales.

Here in Australia, as in the rest of the world, the particular features of this type of boiler are appreciated by the experienced user.

Cochran Sinuflo Economic boilers are designed and built to give long service, *continuous* high efficiency, full accessibility to all water surfaces and convertibility from solid to liquid fuel-firing and vice versa.



COCHRAN BOILERS

Cochran & Co., Annan, Ltd., Annan, Dumfriesshire, Scotland, and at 34 Victoria Street, London, S.W.1.

TAS. CH.607

C. R. Zimmerman

Zimmerman Heads Bethlehem Supply

C. R. Zimmerman, executive vice president of Bethlehem Supply Co. since 1948, has been elected president to succeed G. A. Tompson, who retired on Jan. 1.

Mr. Zimmerman was first employed by Bethlehem Steel in 1927 in the pipe mills of the Sparrows Point plant. He subsequently became assistant chief inspector and then special representative in the mills, and in 1938 was transferred to the general offices at Bethlehem as a salesman in the pipe division.

He joined Bethlehem Supply in 1947 as assistant to vice president, and was appointed executive vice president the following year.

Mr. Tompson first entered the petroleum industry in 1917 when he was employed as buyer and assistant purchasing agent by Cities Service Co., later becoming manager of purchasing and stores.

In 1936 Mr. Tompson was elected vice president in charge of sales of Taubman Supply Co. Following acquisition of Taubman by Bethlehem in 1937, he was appointed vice president, sales and operations, of Bethlehem Supply, serving in that position until 1948, when he was elected president.

Mission Elects White As President

Richard E. White has been elected president of the Mission Manufacturing Co., it has been announced by Walter B. Sharp, chairman of the board. Until Mr. White's election, Mr. Sharp served as both president and chairman.

The new president of Mission, the world's largest manufacturer of fluid end pump parts, has been with the company since 1938, the year he was graduated from Texas A. and M. College. He started with the company as a junior engineer and was appointed plant superintendent in 1942.

Mr. White served with the Navy during World War II and was named production manager at Mission following his return from service in 1946. He was named works manager in 1948, general manager in 1954 and executive vice president in 1955.

Among important posts held by Mr. White in industry associations is that of chairman of the Export Operations Committee of the Petroleum Equipment Suppliers' Assoc.

Richard E. White

Japanese Company Formed

Foster Wheeler Corp. and Ishikawajima Heavy Industries Co. Ltd., of Tokyo, Japan, one of the oldest heavy industrial corporations in Japan and an exclusive licensee of Foster Wheeler in the boiler and condenser fields, have formed a Japanese corporation known as Ishikawajima Foster Wheeler Co. Ltd. Corporation was registered in Japan, November 18, 1957, to sell, design, engineer, and construct process plants for refining petroleum, vegetable oils, fatty acids, and producing chemicals.

The office of this firm will be at 54 Tsukudajima, Chuoku, Tokyo. William A. Sullivan is chairman, and Toshiwo Doko is president of the new company.

Deeper Drilling, Fewer Wells in USA

Average well depth was greater in 1957 than in any previous year, according to American Assn. of Oilwell Drilling Contractors. The association's annual compilation of drilling statistics showed a 7.9% decline from 1956 in total well completions. The 1957 total of 53,668 was down 4,603 from the 1956 record high of 58,271. Average depth of wells drilled in 1957 was 4,120, compared with 4,022 in 1956 and 4,044 in 1955. Because of the fewer wells drilled, total footage was down more than 3 million feet from the previous year, to 221,112,160 ft.

Average contract cost per foot drilled fell in 1957 to a 10-year low of $4.60. Total drilling cost per foot including materials and services in addition to those provided by the contractor, rose to an all-time high of $14. Contractor charges to the operator are only 32.8% of total costs of drilling.

The AAODC 1957 statistical summaries show contractors continued to drill most USA wells, an indicated 93%. Contractor-drilled footage amounted to 205,634,309—with 49,911 well completions.

THE FLOOR AREA OF THIS OFFICE COVERS 107,214,025,881,600 SQUARE FEET

It's quite a large office. It has to be because it covers all of Canada. This is the office of the Natural Resources Development Department of Imperial Bank of Canada. From this office we investigate the potential resource development fields, and gather information and statistics concerning new and established development areas. Mr. R. J. Redrupp, Superintendent of the Natural Resources Development Department, is able to offer financial advice and assistance to businessmen engaged in developing Canada's rich natural resources. He works closely with Mr. A. S. de Rosenroll, Imperial Bank's resident specialist to the oil industry at Calgary, Alberta. This vital new department, first of its kind in a Canadian bank, is another example of Imperial Bank leadership.

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International News and Notes

Mr. Khrushchev Prophesies

Speaking at the recent jubilee session of the Supreme Soviet in Moscow, Mr. Khrushchev made some highly revealing statements on the future economic intentions of the Government of the USSR. As he saw it, the challenge before the Russian people was that of surpassing as quickly as possible the per capita output of the more developed countries. His optimism is based on Russia's great natural wealth together with technical and scientific knowledge with which she is now well equipped.

The figures which Mr. Khrushchev quoted are significant. This past year's production of major energy sources is equivalent, on a calorific basis, to roughly 580 million tons of coal, of which coal and lignite account for 68%, oil 25%, natural gas 4% and hydroelectricity about 3%.

Oil production, Mr. Khrushchev believes, will rise 3½ to 4 times and natural gas production 13 to 15 times in the next 15 years, while coal production is expected to go up by approximately 50%. It is intended to quadruple the output of electricity in this period, partly through the development of water power. Surprisingly Mr. Khrushchev made no reference to nuclear power.

The attraction of oil and natural gas seems largely due to the lower production costs of these fuels. Furthermore—although this point was not mentioned—long distance transport of increasing quantities of coal would undoubtedly burden the overworked transport system. On the other hand, the long distance pipeline systems, already laid or planned, provide a far more economical form of transport than anything possible for coal.

Commenting upon Mr. Khrushchev's prophecy, it may be said that the new long term targets for oil and gas production though highly ambitious are not necessarily unattainable. The rise in oil output represents an annual average increase of 20 million tons a year over the next 15 years, or a yearly advance of 9% compound. For a broadly comparable jump in oil output—from, say, 100 to 350 million tons a year—the United States took about 30 years, from 1925 to 1955. No doubt production could have been accelerated if demand had required it.

It must be recognized that there is some good basis for Mr. Khrushchev's forecasts. The Ural-Volga area, where oil production has now probably reached well over 60 million tons a year, covers a vast territory, more than two-thirds the size of Texas. New oil wealth also exists in Soviet Central Asia, where promising reserves have recently been found in the province of Bukhara; production in Azerbaijan—16 million tons during the past year—is also rising. But apart from the established oil provinces, a large part of the USSR is underlain with sedimentary formations and cannot yet have been adequately explored. The Russians undoubtedly possess the technical knowledge and personnel for such exploration. It is also worthy of note that Russia is looking for oil in Syria, a project included under the comprehensive Economic Aid Agreement recently concluded between the two countries. This very lengthy speech of Mr. Khrushchev's gave only the barest outline of the long-term planning of Russia.

But as a glimpse of future intentions and the scale on which development is envisaged, the new target figures deserve more than the scant attention they have so far received in the West.

Leases Refinery in Greece

Socony Mobil Oil Co. Inc. and associates have been awarded by Greek government a 10-year lease of their newly completed refinery. Rated capacity of the refinery, located at Aspropyrgos, near Athens, is 27,000 b/d. Equipment includes a crude distillation unit and a catalytic reformer for production of high-octane gasoline. The refinery is expected to supply most of the requirements of all major products in Greece except aviation gasoline and lubricants, which it will not manufacture at all.

Rig for Libya

Camdrill International has shapped a new drilling rig to Libya, where Camdrill is under contract for a test of Socony Mobil Oil Co.'s concession. The Mid-Continent Supply Co. rig is powered with Cummins turbo-diesel engines, and Mid-Continent also shipped a heavy-duty rig to Socony Mobil Co. de Venezuela for deep-test service in the Anaco area.

Send Two Rigs to Iran

Southeastern Drilling Co. recently sent two heavy-duty rigs to Iran. Addition of the new rigs brings Southeastern's total in foreign service to five. The new rigs were completely assembled and tested at S & R Tool and Supply Co.'s Houston rig-up yard. Both are 20,000-ft rigs. Airconditioned living quarters for the crew accompanied the shipment.

Plan Libya Test

Oasis Oil Co. has shipped a heavy rig to Libya for the first test on its 62-million-acre concession. The rig will be unloaded at Tripoli and trucked 400 miles to the test site. International Drilling Co. NV is the contractor. Oasis has conducted surface and seismic surveys prior to staking the test location.

COR Becomes BP Australia

The Commonwealth Oil Refineries Ltd., Melbourne, Australia, has changed its name to BP Australia Ltd. The change is in accordance with the general policy of establishing the BP prefix in the names of all companies in the BP group. To publicize the new name, a special advertising campaign was planned in the major Australian newspapers. The new BP sign now appears on some 100 company flags, 120 bulk storage tanks at 105 country depots, on road tankers, drums, cans, and on 600 cap badges and about 5,000 uniform buttons!

Agreement is signed in New Dehli for a new company, Oil India Private Ltd.

Oil India Ltd.

Following the signing in New Delhi, January 14, of an agreement between the government of India and the Burmah Oil and Assam Oil companies, a new 50 crores oil company, to be named Oil India Private Ltd., will be set up to develop the newly discovered oil areas of Upper Assam, and to build pipeline facilities from the wells to government-sponsored refineries in Assam and at Barauni in Bihar. An accompanying photograph (taken during the signing ceremony at the Ministry of Steel, Mines, and Fuel) shows agreement being signed by Sri K. K. Sahni, Joint Secretary of the Ministry, and R. P. Smith, managing director of The Burmah Oil and Assam Oil companies. Also present at the ceremony were Sri N. R. Pillai, Secretary General, External Affairs Ministry; Sri S. S. Khera, Secretary of the Ministry; Sri S. Ratnam, Secretary, Finance Ministry; W. A. W. Clark, Acting High Commissioner for the United Kingdom; G. J. MacMahon, UK Senior Trade Commissioner; and W. P. G. Maclachlan, General Manager of Assam Oil Co. Ltd., Digboi.

Magnetic Survey of England

Magnetic maps for a 15,000-square-mile survey of southern England were delivered in London during October to the Geological Survey and Museum. This is a research establishment of the Department of Scientific and Industrial Research, London. Gulf magnetometer was used at a flight altitude of 1,800 ft. Traverses were flown in a north-south direction at 2-kilometer intervals. Overland navigation was by visual means, with the flight path recorded by a 35-mm continuous strip carera. Over water, the Decca navigator system was used.

Oil Shows at India's Moran Well

Oil shows have been reported at Moran well No. 6, latest in the Assam Oil Co.'s exploration and drilling program in Brahmaputra valley. New well was completed, January 1, 1958, to 11,622 ft. Drilling is now in progress at Moran well No. 7, and further well locations are on the way.

U.S.S.R. INDUSTRIAL PRODUCTION
(Million Metric Tons, Unless Otherwise Stated)

	1913	1928	1950	1957	1955	1957	1972 (Target)	1957-1972 Average % increase p.a. (f)	USA Production 1956
Coal (a)	29.2	35.3	165.9	261.1	391.0 (d)	462	650-750	2½	480
Crude Oil	10.3	11.6	31.1	37.9	70.8 (d)	98	350-400	9	353
Gas (Th. Million Cu M) (b)	0.0	0.3	3.4	6.2	10.4 (d)	21.4 (e)	270-320	18½	210
Electricity (Th. Million kWh) (c)	2.0	5.0	48.3	91.2	170.1 (d)	210	800-900	9	682
Iron Ore	9.2	6.1	29.9	39.7	71.9	84	250-300	7½	98
Pig Iron	4.2	3.3	14.9	19.2	33.3	37	75-85	5	69
Steel	4.3	4.3	18.3	27.3	45.3	51	100-120	4½	104.5
Cement	1.8	1.8	5.7	10.2	22.5 (nearly)	29 over	90-110	8	53
Sugar	1.4	1.3	2.2	2.5	3.4	4.5	9-10	5	2.4
Woolen Fabrics (Million inches)	107.7	86.8	119.7	155.2	251.0	280	550-650	4½	299
Leather Footwear (Million Pairs)	60.0	58.0	211.0	203.4	274.5	315	600-700	4½	586

(a) The 1913-1957 figures include lignite (about 115 million tons in 1955), the 1957 total being equivalent to 395 million tons of hard coal; it is not clear whether the 1972 target includes lignite.
(b) All types, with natural gas predominating.
(c) Hydro-electricity production, included in the total, was 23.100 million kWh in 1955.
(d) Figures for 1956 are: Coal 439 (including lignite 125), Crude oil 83.8, gas 13.7, electricity 191.
(e) Planned figure published early in 1957; no later statement available.
(f) Figures show compound rate of increase required to reach the lower target figure in preceding column.

"An investment is good only if it is mutually beneficial to the investor and the people of the host country. When the proper climate exists for capital investment, many benefits come to countries where investments are made. While the investor expects a return on the investment, the additional capital generated is plowed back into the host country to underwrite the continuation of industrial development."

—Eugene Holman, Chairman of the Board, Standard Oil Company (New Jersey)

ESSO

STANDARD OIL COMPANY (NEW JERSEY)

AND AFFILIATED COMPANIES

Security Engineering Appointments

John C. Helies has been appointed executive vice president, covering all activities except sales, for Security Engineering Division of Dresser Industries. A. M. Birnie is executive vice president in charge of worldwide Security sales. Henry L. Sisk has been named Security's manager of industrial relations. He, too, formerly was with Dresser, the parent company, as a staff assistant on industrial relations.

Fortune Petroleum Moves

Corporate offices of Fortune Petroleum Corp. have moved to larger quarters located in a new building at 14621 Titus Street, Van Nuys, Calif.

New Schlumberger Representative

Charles A. Doh has been named USA representative for the foreign subsidiaries of the Schlumberger organization. Formerly he was manager of customer relations for Schlumberger Well Surveying Corp.

Subsidiaries are Schlumberger Overseas SA, operating in the East and Far East; Schlumberger Surenco SA, operating in South America; and Soc. de Prospection Eléctrique, which is active in Europe.

Mr. Doh is a graduate of the University of Arts and Crafts in Paris, France, having received an MS degree in 1933. He became associated with Schlumberger in 1934, and worked in various locations in Romania, Venezuela, Texas, and Illinois.

He served as Illinois division manager from 1945 to 1951—moving to New Orleans as manager of the Southwest area. In 1956, Mr. Doh was transferred to Houston as manager of customer relations. He will continue to make his headquarters in Houston.

Precise Adiabatic Calorimeter

An adiabatic calorimeter providing high precision within the temperature range from 30C to 500C has been developed by E. D. West and D. C. Ginnings of the National Bureau of Standards. Highly integrated temperature controls, and a design based on systematic error analysis, make possible 0.1% accuracy over most of the temperature range. The present apparatus consists of two basic parts: the calorimeter proper, where energy added is accurately accounted for; and a surrounding adiabatic jacket which prevents gain or loss of heat.

Kouka New CB&I Foreign Head

Chicago Bridge & Iron Co. has announced the appointment of Fred Kouka as manager of the company's foreign erection division with headquarters in New York. Mr. Kouka, who joined CB&I in 1942, has been a member of the foreign erection staff for the past three years. He was assigned previously to CB&I offices in Chicago and Hillside, New Jersey.

Security Promotes Haning

Walter L. Haning has been appointed chief sales engineer for Security Engineering Division of Dresser Industries. He formerly was chief field engineer, and has spent the past 10 years in the rock-bit business doing field engineering throughout the United States and Canada.

To Build Cumene Plant

British Hydrocarbon Chemicals Ltd. will build a plant at Grangemouth, Scotland, to produce high-purity cumene for the manufacture of phenol at the same location. It is scheduled to go onstream about the middle of 1959. Scientific Design Inc. will design the new plant, using the Standard of Indiana process.

British Hydrocarbon Chemicals Ltd., which is jointly owned by British Petroleum Co. and Distillers Co. Ltd., operates a large petrochemical complex at Grangemouth—including, in addition to the cumene and phenol plants, carcking units for production of unsaturated hydrocarbons such as ethylene, propylene, butadiene, etc.

New Executive Plane

Aero Design & Engineering Co. unveiled a new Aero Commander—the "Alti-Cruiser," in conjunction with its recent annual distributor meeting in Oklahoma City. The new plane is pressurized and airconditioned—the world's first light twin executive aircraft to be so equipped.

The new model is available in either a six-place or a four-place version with complete lavatory facilities as standard in the four-place model. The instrument arrangement has three separate panel groups—one with flight instruments, electrically-driven for pilot use, and a similar set vacuum-driven in co-pilot's side. The engine instruments located in the center panel are mounted above a completely new custom control quadrant.

The cabin pressurization system is a proved, dependable airline type unit which will provide sea-level cabin pressure to almost 5,000 ft. At higher altitudes, this pressurization permits "over the top" travel without the use of clumsy oxygen masks.

The interiors of this new Commander are in keeping with its position of leadership in the executive aircraft field. Luxurious contoured seats with tuck-away arm rests recline for maximum rest and relaxation. Cabin appointments are rich in detail and decor, with generous use of leather and wood paneling.

The Aero Commander is manufactured in two models; the 560-E and the 680 Super. The new 680 Super model is powered with two 340-hp Lycoming supercharged engines capable of climbing 1,625 ft per min to a service ceiling of 25,567 ft—cruising at 230 mph, and flying 1,500 miles nonstop. It has a useful load of 1.25 tons, and can land and take off safely from short fields.

New French Refinery Planned

L'Onnium Français de Pétroles, Paris, has been organized to erect a three-millon-ton (60,000 b/d) refinery at Bourgogne to serve east-central France, which now has no local plant. The new project would supplement the proposed Strasbourg refinery which had been planned as a supplier for the northeast industrial area in the Rhine valley.

Proposal is to build a 22-in. 250-mile pipeline from Marseille to Bourgogne to serve the now Onnium Français plant—a line which could be extended to Strasbourg in case that refinery is built. For easy construction, the line would follow the Rhone valley. Initial capacity would be 60,000 b/d, which could be expanded at a later date. Crude source would be North Africa.

Proponents of the new refinery point out that Bourgogne is an ideal spot for a new refinery, since it is in a region far removed from present refinery sources. It is on a waterways complex permitting delivery of products on the Rhone and tributary canals. It is well situated for overland transport by either truck or railroad.

Plans for the plant envisage an atmospheric distillation unit, catalytic reformer, desulfurization unit, LPGas recovery facilities—with general service facilities built on a scale which would permit expansion of the basic refinery to 100,000 b/d. Tankage totaling 2,700,000 bbl is planned for crude and products.

Seismic Crew to Australia

Foreign Oil Explorations, Inc., Tulsa, has sent a seismograph crew to Maryborough, Queensland, Australia, to start reconnaissance on a 33-million acre concession of Lucky Strike Drilling Co., Tulsa, and Oklahoma-Australia Oil Co., Australia. Concessions are in the Maryborough and Great Artesian basins. Weldon Hightower will be in charge of the seismic crew.

Jameson IPAA Vice President

First major reorganization in the history of the 29-year-old Independent Petroleum Assn. of America has been formalized by its executive committee and announced by IPAA President Gordon Simpson, of Dallas. The changes involve creation of five functional departments responsible for the association's activities in government relations, statistical and economic studies, public and industry information activities, membership extension and administrative affairs.

Minor S. Jameson, Jr., IPAA staff member since 1937, has been elected executive vice president, and designated to coordinate departmental activities and the overall program of the association. Russell B. Brown, general counsel for the association since 1930, will continue to be responsible to the president in his top policy position as head of the association's legal department, responsible for its governmental relations activities.

Pipeline Tariff Issued

Texas Eastern Transmission Corp. has issued tariffs covering transportation of oil products through the "little big inch" pipeline from the Gulf Coast to Chicago and other midwestern cities. The 1,179-mile line was converted from gas to products after a battle before the Federal Power Commission. New rates are 48 cents per barrel from Beaumont, Texas, to Chicago, and 45 cents to Indianapolis.

Dresser Promotions

R. E. Reimer has been elected executive vice president, and will also continue to serve as treasurer of Dresser Industries Inc. John Lawrence was also named as an executive vice president. Thomas L. Moody was appointed vice president in charge of industrial relations. J. Douglas Mayson succeeded Mr. Reimer as secretary, and Cecil C. Hill and Paul E. Broderick were made assistant treasurers.

Full speed ahead for 35 . . .

This is a 32 ft. general purpose light alloy launch with accommodation for 35 passengers—one of a number on delivery to The Shell-B.P. Petroleum Development Company of Nigeria Limited. She's powered by a Perkins S.6 Diesel engine and designed for fast, reliable transport of Marine personnel *especially in tropical areas.*

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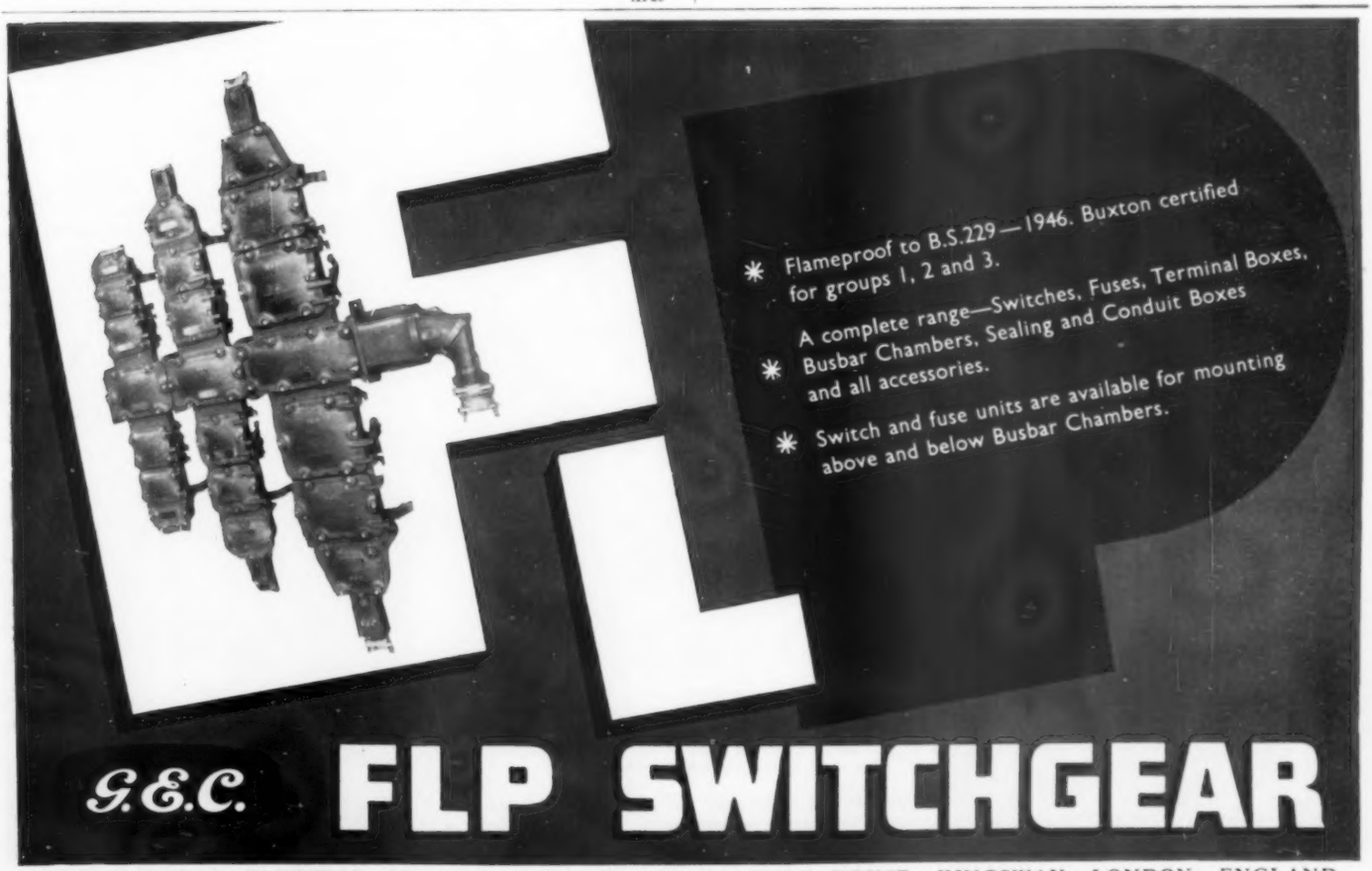
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Oil Company Staff Changes

HAL F. NABORS, Oklahoma City, Okla., has been promoted to general manager of Continental Oil Co.'s central region, which includes Conoco's operations in Oklahoma, Kansas, Missouri, Arkansas, Tennessee, Mississippi, Alabama, Illinois, Indiana, and Nebraska.

B. B. TURNER, president of Ethyl Corp., has been designated chief executive officer of the company. Edward L. Shea, who was formerly chief executive officer, will continue as chairman of the board. Mr. Turner has been president of Ethyl Corp. since 1956, prior to which he served as executive vice president. Mr. Shea was named chairman of the board in 1956, after serving as president since 1947.

W. R. STEVENS of Little Rock, Ark., has been elected president of Arkansas Louisiana Gas Co., succeeding the late J. C. Hamilton. Mr. Stephens has been chairman of Arkansas Louisiana since January 1, 1957, and will continue in that position, also. D. W. WEIR, of Shreveport, was elevated to the newly created position of executive vice president, and elected to the board. LINDSEY HATCHETT, of Little Rock, also was elected a new vice president.

MARION J. EPLEY, JR., has been appointed assistant to Board Chairman Augustus C. Long of The Texas Co., New York. Mr. Epley has been general attorney for Texaco since 1953.

ARTHUR W. BROWN has been named as employee-relations manager, of Standard Oil Co. (N.J.), succeeding Ralph L. Mason who retires March 1. **WILLIAM H. HADLEY** becomes manager of the insurance and social-security department, the post formerly held by Mr. Brown.

L. T. VICE has been named a vice president of California Commercial Co., wholly-owned subsidiary of Standard Oil Co. of California, and will assume direction of the firm's Washington, D. C. office. Mr. Vice succeeds Woollen H. Walshe, who has been named senior attorney for The California Co., also a Standard subsidiary, with offices in New Orleans, La.

HAROLD W. FLEMING has been appointed director of research for Catalysts & Chemicals Inc.—producer of specialty catalysts for the petroleum and chemical industries, with offices and plant in Louisville, Ky.

CHARLES D. KRIEG of Tretolite Co. division of Petrolite Corp., service and development laboratory in St. Louis, Mo., has been assigned to Houston, Texas, to carry on liaison work of field to the central research and development program.

Charles D. Krieg

P. H. Arnot

R. S. Hatch

R. S. HATCH, general manager, materials supply and traffic; and P. H. Arnot, general manager, operations, have been elected vice presidents of Arabian American Oil Co.—effective, March 15. They will continue to make their headquarters in Dhahran, Saudi Arabia.

Mr. Hatch joined Aramco in 1947. Mr. Arnot has been in Saudi Arabia since 1938, when he joined Aramco as a petroleum engineer.

L. G. (GAYLE) RODGERS, general manager, gas division of Sunray Mid-Continent Oil Co., has returned to his Sunray general office duties in Tulsa, following a year's service with the Oil and Gas Division of the U. S. Department of the Interior, Washington, D. C. In government duty, he served as an industry commodity analyst and as a refinery technologist.

E. ("Pick") McIVER, for the past 10 years West Coast crude-oil purchasing agent for Shell Oil Co., has announced his retirement after 25 years' experience in many phases of oil operation. He joined Shell as a service-station operator at San Bernardino in 1932, and has since engaged in a wide variety of marketing and other company operations, largely of an administrative nature.

KENNETH E. CHAFFIN has been made general superintendent of Louisiana-South Texas Division, Loffland Bros., Tulsa. D. E. Williams has been promoted to assistant general superintendent of the Louisiana-South Texas Division.

PAUL L. WAID has been made assistant superintendent of operations of Loffland Brothers Co. of Canada. He will make his headquarters in Calgary, Alberta.

EDMUND C. AUSTIN has been appointed to the newly created position of director of purchases for The Fluor Corp. Ltd., Los Angeles. Prior to joining Fluor, he was petroleum adviser and assistant general manager of the Canadian Bank of Commerce in Toronto, Canada.

WALTER E. BIERY has been named president of Mid-Continent Pipe Line Co., succeeding J. Marston Lineham—resigned to become vice president and manager of crude-oil supply and transportation for Sunray Mid-Continent Oil Co. and D-X Sunray Oil Co., its refining and marketing subsidiary.

H. C. McCARVER has been appointed manager of exploration for Seaboard Oil Co., Dallas, Texas—replacing R. A. Stehr who will act as special advisor to the exploration department.

ROBERT H. CRAFT and James F. Junge has been elected director of Commonwealth Oil Refining Co., Inc., of Ponce, Puerto Rico.

Mr. Craft, of New York, is president of Chase International Investment Corp., foreign financing subsidiary of The Chase Manhattan Bank.

Mr. Junge, of Jenkintown, Pa., is an independent petroleum engineer associated with Wellington & Woodward, industrial consultants.

JAMES E. STEWART has been appointed senior chemist in infrared applications, and Don W. Carle chief project engineer of the gas-analyzer section of Beckman-Scientific Instruments Division, Fullerton, Calif.

C. F. Dohm

C. F. DOHM has been elected president and director of Pan American International Oil Co., a newly formed subsidiary of Pan American Petroleum—organized to carry out oil exploration and development operations in the Eastern Hemisphere. Its principal offices will be located in New York, with at least one branch office to be established in Europe. Pan American Petroleum Corp. is the wholly-owned producing subsidiary of Standard Oil Co. (Indiana).

Widely known in international petroleum circles as a geologist and executive, Mr. Dohm was formerly president and director of Conorada Petroleum Corp., a subsidiary of Continental Oil Co., The Ohio Oil Co., and Amerada Petroleum Corp.

A graduate of Louisiana State University, where he received his B.S. and M.S. degrees in petroleum geology, Mr. Dohm has had more than 20 years' experience in oil exploration and development activities abroad. He was associated with Standard Oil Co. (New Jersey) and affiliates from 1937 to 1949, in various Central and South American countries. In 1949, he returned to the United States as vice president of Conorada Petroleum. He was elected president and director of Conorada in 1954.

Mr. Dohm is a member of the Pan American Society, the Mexican Geological Society, The American Association for Petroleum Geologists, The American Photogrammetric Society, The American Petroleum Institute, and the Board of Directors and International Advisory Committee of the Council on Islamic Affairs. A resident of the New York area for the past eight years, Mr. Dohm resides with his family in Scarsdale.

H. R. MOORHOUSE has been named executive vice president of Arthur G. McKee & Co., Cleveland. He will continue to serve as treasurer.

R. I. BROUGHAM, Arabian American Oil Co.'s vice president in charge of finance, is being given additional responsibilities, and will assume charge of concession affairs later this year. Mr. Brougham started his career in the oil industry as an office boy with the Standard Oil Co. (New Jersey) in 1927. After holding a number of executive positions with that company, in 1946 he was made foreign-exchange manager. He joined Aramco in 1947, and in the same year was elected financial vice president.

R. I. Brougham

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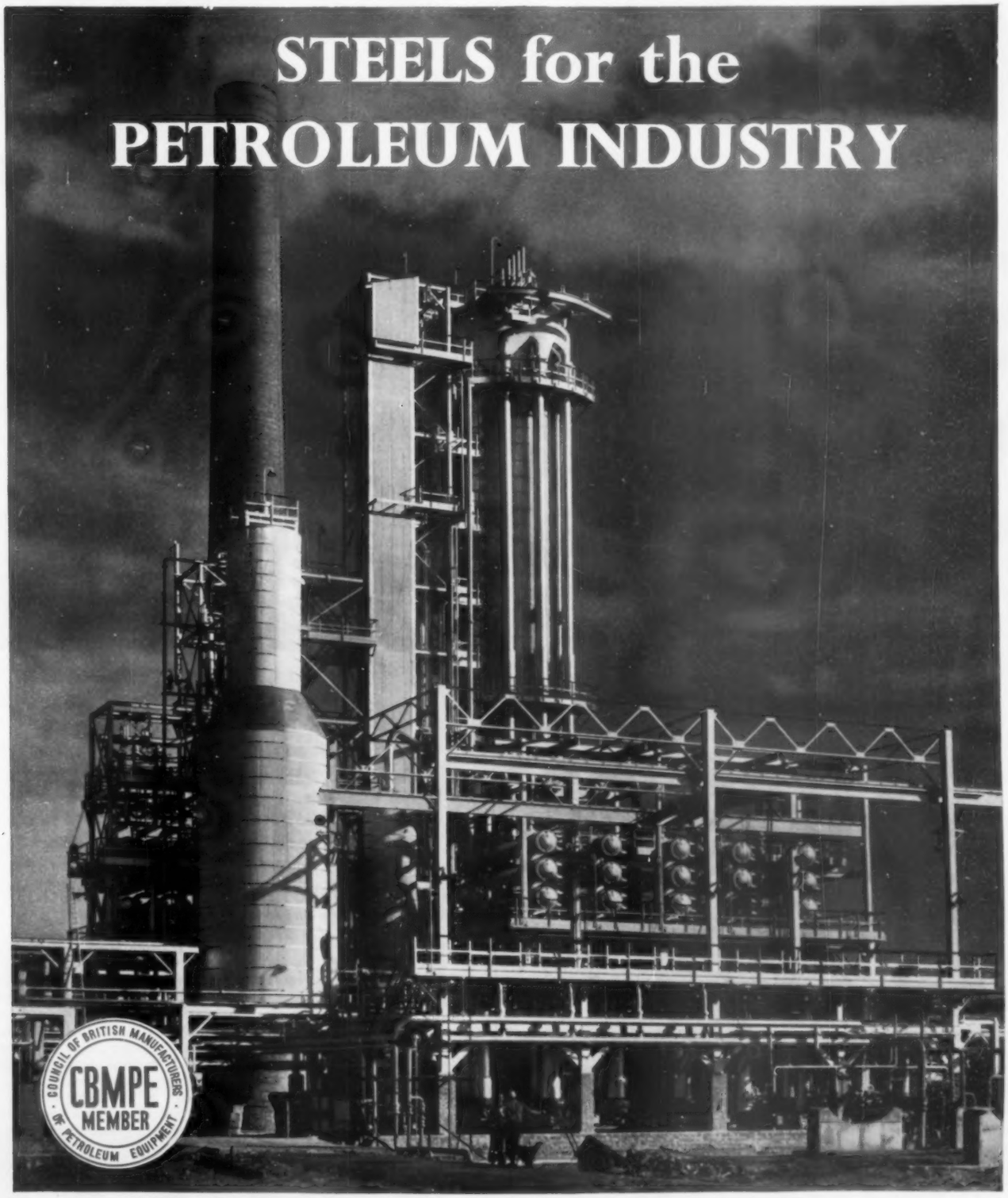

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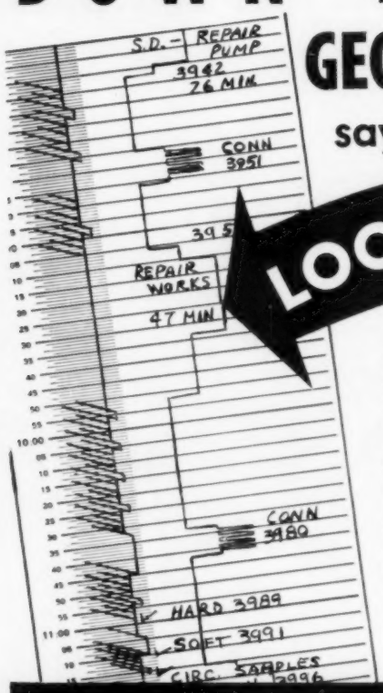

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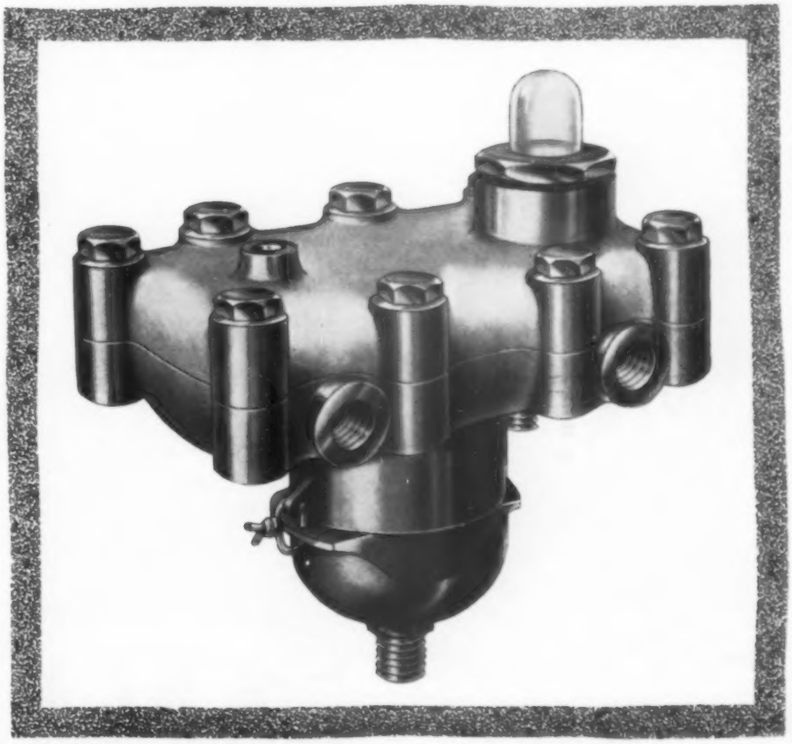

Easily fitted to existing filters, the Vokes Filter Servicing Indicator is an inexpensive, mechanically operated unit. Fitted by copper tubing to the inlet and outlet sides of the filter, it clearly indicates when the filter element is approaching the recommended maximum differential pressure through the collection of contaminants. It can be adjusted and pre-set to operate over a wide range of filter differential pressures and is normally pre-set at the works to suit the application required. Full details of this new Vokes product will gladly be sent on request.

OPERATION

The outer case incorporates a diaphragm dividing the case into high and low pressure compartments, each compartment being connected to the appropriate pressure side of the filter via capillary tubing. Any difference in pressure, and subsequent movement of the diaphragm, applies pressure to an overcentre snap-action spring giving magnified movement at one end. This actuates a vividly coloured thimble, which enters a transparent dome, and is immediately seen externally.

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V276

Vickers Adds Petrochemicals Unit

The Vickers Petroleum Co. Inc. has formed a chemicals division which will operate in conjunction with the $2,500,000 Udex extraction unit now in final phases of construction at the firm's Potwin, Kans., refinery. The BTX petrochemical plant is the first to be constructed by an oil company in Kansas. Additional products are under consideration, and will be announced when these products are determined ready for marketing sometime after April 1, 1958.

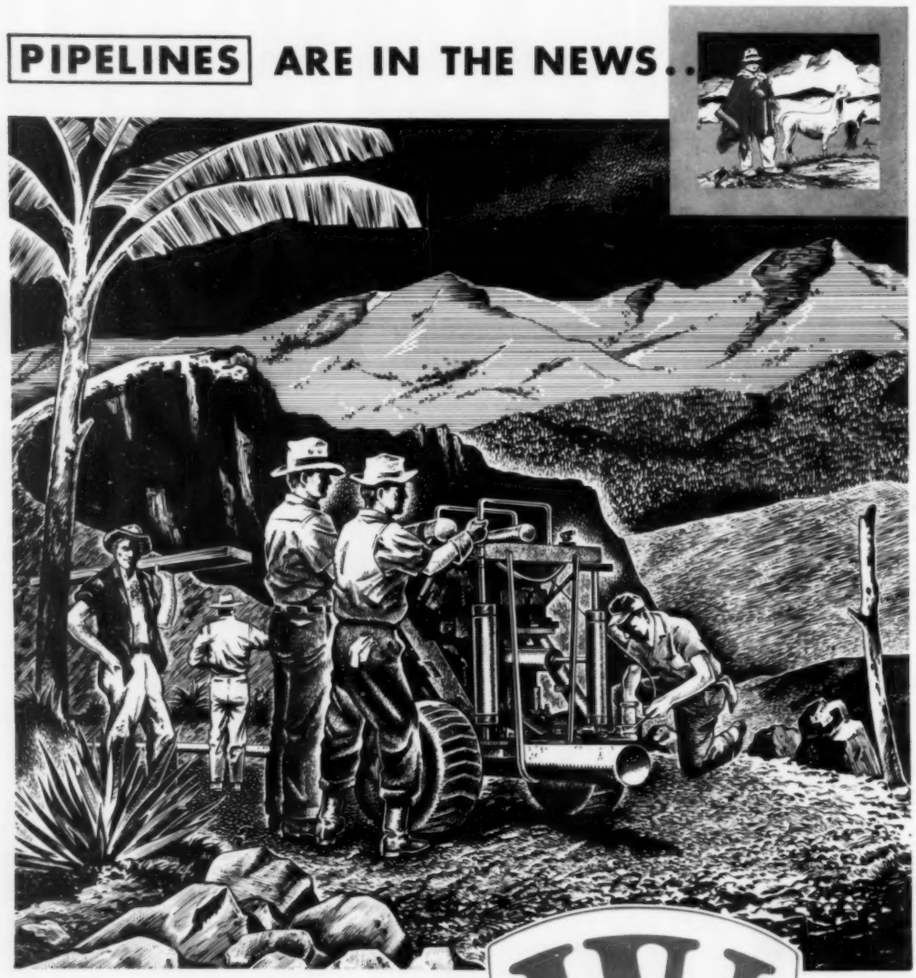
William K. Jackson, Wichita, has been named vice president of research and development and technical assistant to the president. Arthur B. Mullaly, Lawrenceville, N. J., has been appointed vice president in charge of marketing and market development. Mr. Mullaly will work with Mr. Jackson in developing new products and sales opportunities for Vickers' Chemical Division.

New Secondary-Recovery Publication

A Survey of Secondary-Recovery and Pressure-Maintenance Operations in Texas to 1956, third in a similar series of surveys prepared by the Engineering Department of Texas Railroad Commission, has been published by the Interstate Oil Compact Commission.

Humble Benzene Plant Onstream

Badger Manufacturing Co., Cambridge, Mass., has completed Humble Oil & Refining Co.'s new benzene plant in Baytown, Texas. Designed to produce about 30 million gallons of high-purity benzene a year, plant is one of the largest of its kind in the world. Completion marks another big step in Humble's program of expansion in the petrochemicals field. Construction of the unit began in April 1957.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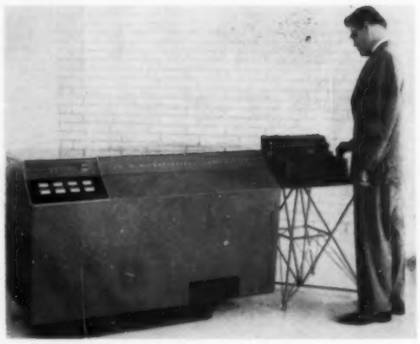

No larger than an office desk, the RW-300 digital control computer measures only 56 in. overall length; is 29 in. wide and 36 in. high; and weighs approximately 400 lb.

Computer Controller

The Texas Co. is installing a digital control computer at its Port Arthur, Texas, works for controlling its catalytic polymerization unit. The control computer is the first of its type, and was manufactured for Texaco by Thompson-Ramo-Wooldridge Products Inc., after an extensive study of the process. The computer now is being offered to the industry on a commercial basis as the RW 300.

The unit itself sells for $98,000, but the complete installation will run from $200,000 to $500,000. Payouts have been calculated at six months to two years on a number of projects studied thus far. The computer will not save manpower, but is intended to improve control of continuous processes to the point where yields and quality will rise sharply.

Special buildings and airconditioning are not required for the RW 300. Construction is modular with built-in test instrumentation for quick trouble-shooting. Individual modules may be replaced readily to provide continuity of service. Little floor space is required.

In plant operation, the unit stores test data and takes control actions based on this accumulation. Instead of recording raw data, the unit performs necessary calculations and prints results in useable form. It can monitor process instruments for failures or dangerous conditions. It expedites startup to standardized conditions. In normal operation, measuring devices send signals direct to the computer which converts them to digital form, solves necessary equations for proper control, changes results to analog form in the output conversion equipment for actuation of controllers.

Offshore Mud Service

The Milwhite Mud Sales Co. has recently placed in service a 118-ft vessel, the "M/V Grand 33," for delivery of drilling-mud material in bulk to offshore drilling locations in Southeast Louisiana. Based at New Orleans, the "Grand 33" can transport up to 200 tons of bulk mud-weight material, as well as 2,000 100-lb sacks on deck, at an approximate speed of 10 miles per hour. The bulk material can be delivered to a drilling rig's tanks through the vessel's light-weight 250-ft hose at the rate of 100 tons per hour.

New Houston Nomad President

Ed Louden (left) new president of the Houston chapter of the NOMADS, receives the gavel with which he will rule this year from T. T. Word, Jr., outgoing president. Second from left is W. O. Hedrick, senior regent; and next to him is Harry Estes, executive secretary.

THE "EVGENIA NIARCHOS"

sister vessel to the highly successful *Spyros Niarchos*, is now in service. On an overall length of 757 feet, she carries 47,000 tons deadweight and has a maximum power of 20,000 S.H.P. Her propeller, like that of the *Spyros Niarchos*, is the largest manufactured in Novoston alloy. It is of Heliston design, five-bladed and weighs 30½ tons.

Photograph by courtesy of the builders, Vickers-Armstrongs (Shipbuilders) Ltd.

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Jesser New Kellogg Manager

Kellogg International Corp., London, a subsidiary of the M. W. Kellogg Co., New York, has announced appointment of B. W. Jesser as manager. Mr. Jesser will relieve F. E. Johnson, Jr., who has been manager for the past four years and who has just been named an assistant engineering vice president of the parent company in New York. Mr. Jesser was a contract operations staff engineer in M. W. Kellogg's New York office, and was formerly manager of the company's design engineering department. He has been with the company since 1942. Prior to this he was an instructor in chemical engineering at Princeton University and was with DuPont.

Petroleum Department Vice President

Charles R. Dodson has been appointed a vice president in the petroleum department of The First National City Bank of New York.

Mr. Dodson is treasurer and a director of the American Institute of Mining & Metallurgical Engineers. He joined the bank on March 1, 1954.

Pipeline Zipper

The Zippertubing Co., Los Angeles, has developed a flat vinyl-backed, uncured butyl-rubber cover for pipelines which is shut by means of a plastic track. It is available in widths wide enough for the largest pipe. When zipped around the pipeline, the uncured butyl will cold-flow into valleys, pits, or scratches in the pipe. After the rubber cures, it forms a permanent, completely waterproof jacket, which, if later nicked or cut, will cure itself. One man now can seal approximately 1,000 ft of Zippwrap per hour.

Heads Cardwell Advertising

The appointment of Charles C. Hamblin as advertising manager for the Cardwell Manufacturing Co., Wichita, Kans., has been announced by Paul Courtney, general manager. Mr. Hamblin was formerly with the International Harvester Co., in its sales division.

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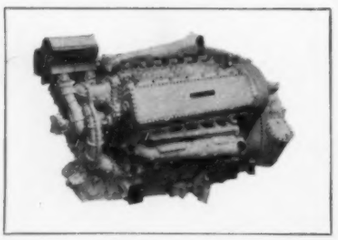

Napier Deltic 18-cyl. opposed piston, 2-stroke diesel marine power unit.

Deltics—Napier-engineered, high speed diesels—reduce shore-to-rig crew transportation times by 50% and more.

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The boat illustrated is one of the fleet of Thornycroft-built, twin Deltic powered, 50-passenger crew launches operated by the Shell Petroleum Company on Lake Maracaibo. Plans of Deltic powered crew boats suitable for Gulf operation are available.

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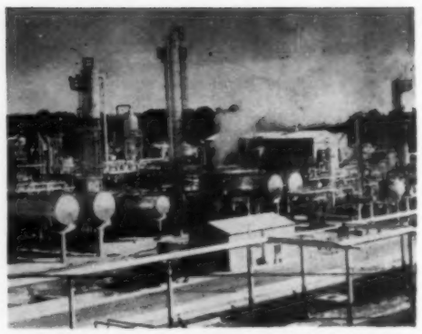

W. R. Grace and Company's new high density polyethylene plant at Baton Rouge, La.

Polyethylene Plant Onstream

W. R. Grace and Co.'s polymer chemicals division recently began operations at its new polyethylene plant at Baton Rouge, La. The plant has an annual capacity of a million pounds of high-density product manufactured by the Phillips low-pressure process. Fluor Corp. was contractor for engineering and construction of the $18 million plant.

Ethylene for the plant is obtained from the nearby refinery of Esso Standard Oil Co.

H. C. Smith—Herschel C. Smith

H. C. Smith Oil Tool Promotions

At a recent meeting of the board of directors, Herschel C. Smith was elected president of H. C. Smith Oil Tool Co. He was formerly executive vice president. H. C. Smith, founder and previous president of the company, was named to the newly created position of chairman.

Herschel C. Smith, who has been with the company since 1936, was made general superintendent in charge of production in 1943, and became secretary and general manager in 1945. He was elected vice president and general manager in 1953 and, two years later, became executive vice president.

Joseph M. Sexton

Sexton Appointed at Kellogg

Joseph M. Sexton has been appointed general manager of Ste. Kellogg, the company's Paris subsidiary. Mr. Sexton was manager of purchases since 1956. He joined M. W. Kellogg in 1942 as an inspection engineer. In 1950, he was appointed manager of plant purchases at the Jersey City plant, and transferred to M. W. Kellogg's London subsidiary, Kellogg International Corp., in 1953, as manager of purchases.

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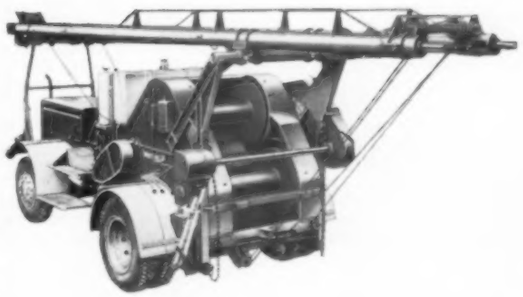
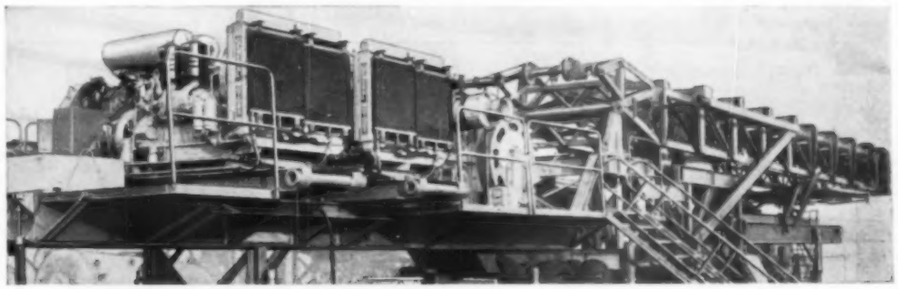
Woodfield are licensees in the United Kingdom for the manufacture and sale of the range of IDECO drilling and production equipment.
The Woodfield plant at Rochester, constantly developing and enlarging its facilities, provides the means of producing first-class equipment. This, combined with frequent visits of senior technical and service personnel to fields and installations the world over, provides a service indispensable to operators requiring special equipment.



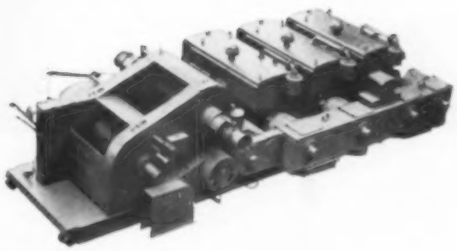


Top illustration:
Woodfield "Fieldmaster" Mobile Well Servicing and Workover Rig. Well depths up to 4,000 ft.

Centre illustration:
WOODFIELD built IDECO Hydrair H-525 Dual Rambler drilling and servicing rig for wells 7,000/8,000 ft. depth. Drilling to 7,500 ft. with 4½" drill pipe.

Right illustration:
WOODFIELD built IDECO Hydrair H-40-D Double drum draw-works with 3 AEC engines, 450 H.P. and 4 shaft drive compound.

Lower right illustration:
WOODFIELD built IDECO H-20 double drum Well Servicing Rig. Well depth 3,000-4,000 ft.



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R. E. Howe

W. Vaughan Ischie

SINCLAIR BROADENS MANAGEMENT BASE

As a further step in the company's program to broaden its management base in line with expanding business, P. C. Spencer, president of Sinclair Oil Corp., has announced the following appointments:

James E. Dyer, since 1954 president of Sinclair Refining Co. (manufacturing and marketing subsidiary), has been elected vice chairman of the board of the parent corporation.

Following promotions are in Sinclair Refining Co.: Thomas B. Kimball becomes president—succeeding Mr. Dyer; and James A. Ahearn becomes executive vice president. W. Vaughan Ischie has been elected director of manufacturing, to succeed Mr. Kimball. E. W. Griscom has been elected vice president, director, and general manager of manufacturing—succeeding Mr. Ischie. R. E. Howe becomes vice president and executive assistant to the president—succeeding Mr. Ahearn.

The several executives who have been promoted have all had long records of service with Sinclair.

Mr. Dyer began in the oil business in 1915 with the Cudahy Refining Co., which two years later became the Sinclair Refining Co. He has served in various capacities in marketing, transportation, supply and distribution.

Mr. Kimball joined Sinclair's research and development department in 1930 in East Chicago, Ind., and was later placed in charge of process engineering. Transferred to New York in 1943, he was named assistant manager of refineries in 1950, becoming vice president and director of manufacturing in 1956.

Mr. Ahearn started with Sinclair in 1924, and served in various capacities in the marketing department—becoming assistant to the marketing vice president in New York in 1942. He was made vice president and director of supply and distribution in 1952, and became executive assistant to the president in 1957.

Mr. Ischie entered the service of Sinclair Refining in 1921, in research and development, in East Chicago, and later was transferred to the operations department of the East Chicago refinery. He was loaned to PAD during Korean hostilities, where he served as director of foreign refining. On his return to the company, he later became vice president and director and general manager of manufacturing.

Mr. Griscom started with Sinclair Refining in 1928 in the technical department at Marcus Hook, Pa. refinery. In 1954 he became manager of the East Chicago refinery, and later transferred to the home office manufacturing department.

Mr. Howe joined Sinclair Refining in 1934 in research and development. He transferred to the refinery at Sinclair, Wyo. in 1936, and was made manager in 1950. He was brought to New York in 1955 as manager of processing and planning for the manufacturing department.

Gillingham New Schlumberger Head

William J. Gillingham, who joined Schlumberger Well Surveying Corp. only five years after the corporation's first electric logging project in this country in 1929, has been named president of the firm, Pierre Schlumberger has announced. Mr. Gillinghham has been executive vice president.

Mr. Gillingham, who as an engineer and field operating man has helped develop markets for a number of logging techniques and tools, became interested in the field of electric logging when Conrad Schlumberger, one of the company founders, lectured at the Royal School of Mines early in 1934.

Returns From Brazil

A. E. Gooch, assistant chief engineer for the American Iron & Machine Works Co. Inc., of Oklahoma City, recently returned from a trip to Brazil. A major portion of his time was spent in the Amazonos and Bahia districts. His trip was directed by Mr. Pio Castagnoli, who represents Cia. Nacional de Sondagens, authorized distributors of American Iron products in Brazil.

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E. E. Andreason, new president of the New York Nomads (left) being congratulated by his predecessor Maurice F. Delano, Jr.

Andreason Heads New York Nomads

E. E. Andreason of Andreason-Lundberg Corp., was elected president of the New York chapter to succeed Maurice F. Delano, Jr., of R. S. Stokvis & Sons, Inc., who became junior regent.

Chapter vice president for 1958 is Don E. Kircher of Gardner-Denver Co.; treasurer W. E. Volkman of Cardwell Mfg. Co., and assistant treasurer R. L. Le Bus, Jr., of Baash-Ross Co.

New secretary is Hollis W. Halton of Beckley, Halton & Hickman, and assistant secretary John E. George of Mid-Continent Supply Co. Sergeant-at-arms is Harold E. Lowery of Continental Supply. His assistants are D. T. O'Connor and J. W. Chanda of A. O. Smith Corp.

Petrosur Acquires Hydroil

Petrosur Oil Corp. Inc., of Houston and New York, has announced acquisition of Hydroil Inc., Houston —creating a corporate entity active in every major area in the Western Hemisphere. Acquisition was effected by a share-for-share exchange of 810,000 shares.

Petrosur has leases and concessions in Panama, Venezuela, Bolivia, Cuba, and the United States. Its board also has announced election of John W. Flude, geologist of Houston, as president.

LPGas Sales Up 4.1%

Industry sales of liquefied petroleum gas (butane and propane) in 1957 increased by 4.1% over 1956 sales to an estimated 6,907,700,000 gal, according to estimates released in a year-end review of the LP-Gas industry by Geo. R. Benz, W. F. DeVoe, and Paul W. Tucker of Phillips Petroleum Co., Bartlesville, Okla. The estimated increase, although lower than that experienced in recent years, exceeds estimated percentage increases in sales of all other petroleum products during 1957.

LP-Gas sales for domestic and motor-fuel use are estimated at 3 billion gallons—a 4.5% increase over 1956. Petrochemical use rose 6% to 1.7 billion gallons, and consumption for synthetic rubber was 2% higher at 427 million gallons. Industrial, gas manufacturing, and miscellaneous uses accounted for 872 million gallons, unchanged.

Continuous Acetylene and Ethylene Process

A process for the continuous production of acetylene and ethylene from naphtha and natural-gas feed stocks is now offered by the M. W. Kellogg Co., New York. The process, originally developed by Societe Belge de l'Azote (SBA), Liege, Belgium, has been further perfected by the close cooperation of Kellogg and the research and development division of SBA.

Using naphtha as feed stock, a wide range of ethylene to acetylene ratios may be produced, and the flexibility of the process makes possible the simultaneous production of ethylene and acetylene. When natural gas is used as feed, acetylene is the primary product, and any minor quantities of heavy impurities are encountered. The SBA-Kellogg process can be designed to operate on either feed stock.

The heart of this process is the SBA-developed burner. It is easy to control, requires only minimum attention, is stable, and operates continuously to produce a constant yield. Any traces of carbon and residual heavy hydrocarbons are continuously removed by special equipment.

In the process train, the heavy acetylenes and hydrocarbons are separated first, leaving a stream containing acetylene and lighter materials. By using an SBA-developed ammonia-absorption system, acetylene is removed from lighter materials comprised essentially of ethylene, hydrogen, and carbon monoxide, valuable byproducts in themselves. The acetylene, 99.5% pure or higher, is then stripped from the ammonia.

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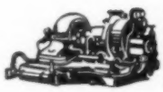

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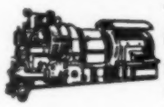

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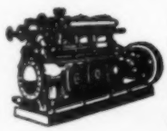

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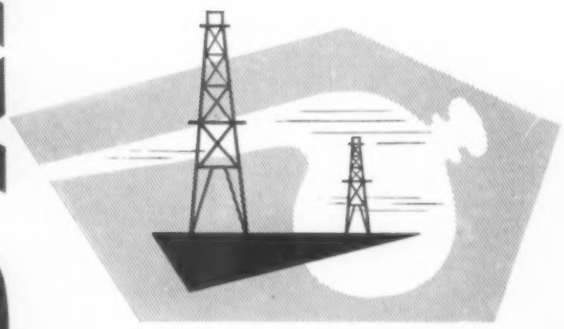

An outstanding development in British industry in the last twenty years has been the expansion of the Petroleum refining and Chemical Industries. The Chemical and Petroleum Engineering Exhibition—the first of its kind—will present dramatic evidence of the tremendous achievements that have been made.

At Stand after Stand, contractors, designers and specialists in every branch of British chemical and petroleum engineering will have something to show of vital interest.

The Exhibition will also include a conference on "The Organisation of Chemical Engineering Projects" arranged by The Institution of Chemical Engineers and The Institute of Petroleum; and films will show how the Chemical Plant and Petroleum Equipment Industries have helped in the development of their consumer industries.

A visit to this Exhibition is a MUST to all concerned in chemical and petroleum projects and to everyone whose industry is in any way influenced by such projects.

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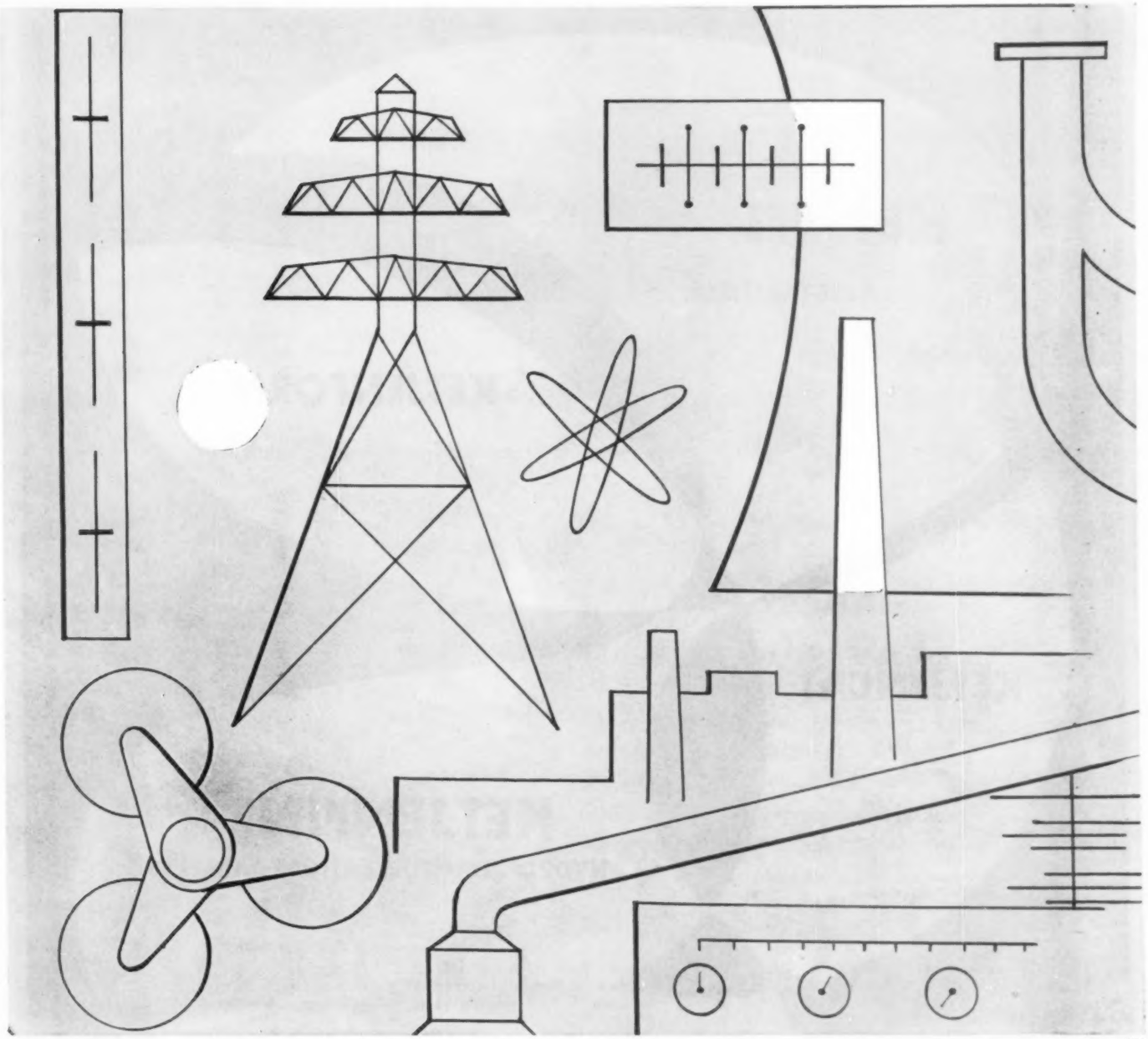

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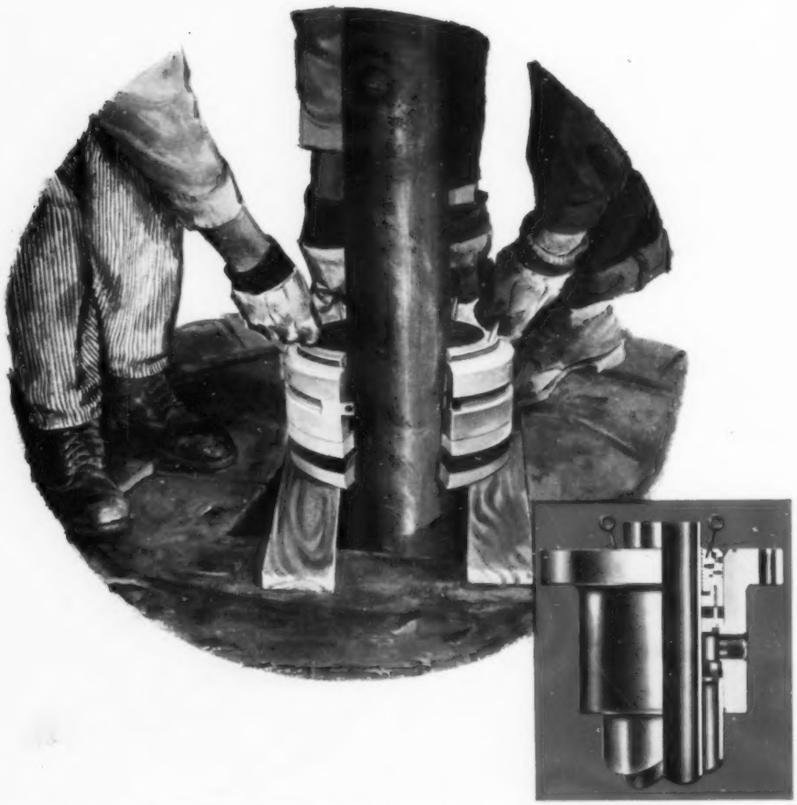

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